PEACH-GROWING

The Rural Science Series
L H Bailey *Editor*

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Edited by L. H. Bailey

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Plate I. — A peach orchard location in the Alleghany Mountains. Elevation 1200 to 1400 feet.

PEACH-GROWING

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To the Memory of

WELTON MARKS MUNSON

INSTRUCTOR IN HORTICULTURE IN CORNELL UNIVERSITY, AND LATER PROFESSOR IN THE UNIVERSITY OF MAINE

TEACHER AND FRIEND, UNDER WHOM THE AUTHOR RECEIVED HIS FIRST HORTICULTURAL INSTRUCTION, AND WHOSE INFLUENCE EXERCISED UNCONSCIOUSLY THROUGH A BRIEF PERIOD HAS CONTRIBUTED GREATLY TO THE YEARS THAT HAVE FOLLOWED

THIS BOOK IS GRATEFULLY DEDICATED

PREFACE

Although the development of peach-growing in the United States has been coincident with the development of the country, peach literature is notably limited except as it appears in experiment station bulletins and reports. Of these there are many.

The motive of this book is to present in a fairly comprehensive way the principles and practice of successful peach production. The amount of detail that enters into some parts of the discussion may seem unnecessary and prove wearisome to the experienced grower, but the author's conception of the book is based largely on a rather extensive observation of fruit-growing problems and the impressions that have come from the handling of a wide range of correspondence. So far as this effort proves of service to the reader who is seeking help in the growing of peaches, the book will accomplish its intended mission.

It is difficult to make full acknowledgment of all credit that should be given. Experiment station literature has been drawn upon very freely. Most of the ripening dates in the chapter on varieties were supplied by peach-growers. The chapter on pruning was reviewed by S. H. Fulton, of West Virginia, a peach-grower of large experience; and the one on insects and diseases, by W. M. Scott, formerly connected with the fruit disease investigations of the U. S. Department of Agriculture, and himself a peach-grower of large interests.

The photographs from which most of the illustrations were made are from the files of the Office of Horticultural and Pomological Investigations, Bureau of Plant Industry, U. S. Department of Agriculture, and are here used with the approval of the Chief of that Office. Although most of them were taken by the author, credit for their use belongs to the Department. Further acknowledgment is made in the List of Illustrations. Finally, the Editor and Publishers have made concessions that should not pass unrecorded.

H. P. Gould

Washington, D.C.,
June 8, 1918

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PEACH-GROWING

CHAPTER I

HISTORICAL NOTES

The peach has been in cultivation since ancient times, so long in fact that it is said commonly to be unknown in the wild state. For an indefinite period it was supposed to be native to Persia. Evidently the Ancients so regarded it, since more than three centuries before the Christian Era the peach was referred to by Theophrastus as a Persian fruit.[1] De Candolle opposes this view with the contention that the peach originally came from China. Perhaps no one can speak in this matter with greater authority than this author.

The peach was received by the Greeks and Romans soon after the beginning of the Christian Era. De Candolle reasons that, had it been grown in antiquity in Persia, it would have reached these peoples at an earlier time. He also places much significance in the fact that there are no Sanskrit or Hebrew names for it. He was convinced such names would have existed had the peach been indigenous to Persia, since the Hebrew- and Sanskrit-speaking people, as

[1] De Candolle, Alphonse, "Origin of Cultivated Plants" (1884 English Translation), p. 222.

well as those of ancient Greece, radiated from Persia and the upper Euphrates Valley or were in communication therewith from the earliest times. "On the other hand," writes De Candolle,[1] "it is very possible that the stones of a fruit tree cultivated in China from the remotest times should have been carried over the mountains from the center of Asia into Kashmir, Bokhara, and Persia. The Chinese had very early discovered this route."

Although in different parts of Asia, in the region of the Caucasus, in the Crimea, and in other regions, the peach has sometimes been reported as occurring in the wild state, there always arises a very definite doubt, amounting to a practical certainty, that it has been introduced and the trees, escaping cultivation, have become naturalized.

Furthermore, De Candolle traces evidence of the existence of the peach in China at a much earlier period than in any other country. He calls attention to the fact that the peach was referred to in the writings of Confucius in the fifth century before the Christian Era, and also in other writings in the tenth century preceding and, he adds: "The peach spreads easily in the countries in which it is cultivated, so that it is hard to say whether a given tree is of natural origin and anterior to cultivation, or whether it is naturalized. But it was certainly first cultivated in China; it was spoken of there two thousand years before its introduction into the Greco-Roman world, a thousand years perhaps before its introduction into the lands of the Sanskrit-speaking race." Thus, if sacred and profane writings be correlated, it would seem that the peach was known in that part of the world which later came to be called China at the time when Lot

[1] De Candolle, Alphonse, "Origin of Cultivated Plants" (1884 English Translation), p. 221.

was separating himself from Abram because of the contention between their herdsmen.[1]

De Candolle's conviction that the peach originated in China was expressed as early as 1855.[2] In the following thirty years, additional evidence tending to confirm his earlier views has accumulated. Moreover, in his agricultural explorations in northern and eastern China within the past few years, for the United States Department of Agriculture, Frank N. Meyer has discovered at least one wild species of peach [3] (and possibly others) which may be the prototype of the cultivated peach, thus strengthening still further the probability of a Chinese origin.

In his explorations in Hupeh and Szechuan in western China, E. H. Wilson found peaches commonly cultivated from river-level to an altitude of 9000 feet. Not only are they grown in orchards and about the houses, but they have sprung up almost spontaneously in many places along the roadsides and on cliffs where they have become practically naturalized. Wilson also refers to the antiquity of the peach in China and mentions the now commonly accepted view of its origin in that country. It is his opinion, however, that "the type of garden peach is no longer to be found in the wild state,"[4] the nearest approach to it being, in his judgment, the subspontaneous form naturalized along the roadsides and other places in the provinces above named.

L. H. Bailey found the peach wild in the mountains separating the drainage of the Yang-Tze and Hwai-Ho rivers,

[1] Genesis 13 : 1–13.

[2] De Candolle, Alphonse, "Origin of Cultivated Plants" (1844 English Translation) p. 221.

[3] Yearbook of the U. S. Dept. of Agr. for 1915, p. 218.

[4] (Wilson, E. H., "A Naturalist in western China," II, p. 26; also, "Plantæ Wilsonianæ," Part I, p. 273).

and also in the low mountains of west-central Honan, growing in the same situations as other plants undoubtedly native, sometimes fruiting as small bushes among the rocks. Whether the peach is indigenous in these regions he considers as very doubtful, inasmuch as China has been the scene of human occupation for thousands of years, and it is difficult to trace food plants to their exact origins there.

INTRODUCTION INTO AMERICA

The time of introduction of the peach into America, or from whence or by whom it came, seems not to be a matter of definite record. That it was within a few years after the landing of the Pilgrim fathers appears certain and that the first introduction was in the form of seeds from England is a presumption that seems both natural and logical, although it may also have had a Spanish introduction.

A most interesting résumé of the references in early literature to the beginnings of peach-growing in America has been made by Smith,[1] from which the following paragraphs are selected as showing the beginning and the dissemination of peach-growing among the early colonists:

"It is uncertain when peach trees were first introduced into this country, but it was prior to 1633. From two entries in the records of the Governor and Company of the Massachusetts Bay in New England,[2] it is probable that they were introduced into the New England region soon after the year 1629. On page 24 of the first volume of these records is an undated memorandum of things 'to prouide to send

[1] Smith, Erwin F., "Peach Yellows: A Preliminary Report," Div. of Botany, Bull. 9, U. S. Dept. of Agr. (1888) pp. 10–17.

[2] Vol. I, 1628–1641. Edited by N. B. Shurtleff, M. D., and published by the Commonwealth, Boston, 1853.

for New England,' among which are included 'stones of all sorts of fruits, as peaches, plums, filberts, cherries.' Somewhat later, in a letter of April 17, 1629, from Gravesend, England, by the governor and deputy of the New England Company to Capt. John Endicott, then governor and council for London's plantation in the Massachusetts Bay in New England, we read (p. 392):

"'As for fruit stones and kernels, the time of the year fits not to send them now, so we propose to do it pr. our next.'

"In 1633 the Dutch sea-captain, De Vries, found peach trees in Virginia in the garden of George Minifie, on the James River, between Blunt Point and Jamestown. They were the first seen by him in North America. The following is copied from the entry in his journal:

"'Arrived at Littletown, where Menifit lives. He has a garden of two acres, full of primroses, apple, pear and cherry trees. . . . Around the house there are plenty of peach trees, which were hardly in bloom.'

"Minifie settled there in 1623.[1] In 1635 appeared the following mention of peach-growing in Maryland:

"'Although there be not many that do apply themselves to plant gardens and orchards, yet those that do it find much profit and pleasure thereby. They have peares, apples, and several sorts of plummes, peaches in abundance, and as good as those in Italy.[2]

[1] "The Founders of Maryland," etc., by Rev. Ed. D. Neill, A.B. Albany, Joel Munsell, 1876, pp. 52, 53.

[2] "A Relation in Maryland." Author unknown. Reprinted from the London edition of 1635, with a prefatory note and an appendix by Francis L. Hawks, D. D., LL. D. New York, Joseph Sabin, 1865, p. 28.

"In 1656 John Hammond wrote of an earlier period:[1]

"'Orchards innumerable were planted and preserved' (p. 9) and of his own time:

"'The country is full of gallant orchards, and the fruit generally more luscious and delightful than here. Witness tbe peach and quince. The latter may be eaten raw savourily; the former differs and as much exceeds ours as the best-relished apple we have doth the crab, and of both most excellent and comfortable drinks are made (p. 13).'

"To the effect that previous to 1683 peach trees were growing thriftily in considerable numbers in other parts of the country, there are statements by at least four persons, Thomas Campanius, 1643–1648;[2] Louis Hennepin, 1679–1682;[3] Mahlon Stacy, 1680;[4] and William Penn, 1683.[5]

"Campanius records finding peaches in three places along the Delaware."

The statements by Stacy are of special interest. Writing from New Jersey, he says, as quoted by Smith:

[1] "Leah and Rachel; or the Two Faithful Sisters, Virginia and Maryland," by John Hammond. London, 1656. Reprinted in Force's Historical Tracts. Vol. 3, Washington, D. C., 1844.

[2] "A Short Account of New Sweden" (in Swedish), Stockholm, 1702. Cf. a synopsis in Tr. Am. Philosophical Soc., Phila., 1816; and a translation by Du Ponceau, Phila., 1834.

[3] Nouvelle découverte d'un très, grand pays, situé dans l' Amerique, entre le Nouveaux Mexique et la Mer Glaciale, etc. Utrecht, 1697, p. 300 and elsewhere.

[4] "History of Pennsylvania in America, etc.," by Robert Proud. Philadelphia, 1797, Vol. 1, p. 153; "History of New Jersey," by John O. Raum, p. 108. Stacy's letter was written from "Falls of the Delaware," April 26, 1680, to his brother Revell and others in England.

[5] "History of the Peach in America," Loren Blodgett. *The Gardeners' Monthly.* Philadelphia, 1882, p. 347; see also Proud's "History of Pennsylvania in America," Vol. 1, p. 249.

"'I have traveled through most of the places that are settled, and some that are not; and in every place I find the country very apt to answer the expectation of the diligent. I have seen orchards ladened with fruit to admiration; their very limbs torn to pieces by the weight, and most delicious to the taste and lovely to behold. I have seen an apple tree from a pippin kernel yield a barrel of curious cider, and peaches in such plenty that some people took their carts a peach gathering; I could not but smile at the conceit of it; they are very delicate fruit, and hang almost like our onions that are tied on ropes.'"

"According to Robert Beverly,[1] peaches grew abundantly in Virginia at the beginning of the eighteenth century. He says:

"'Peaches, nectarines, and apricots, as well as plumbs and cherries, grow there upon standard trees. They commonly bear in three years from the stone, and thrive so exceedingly that they seem to have no need of grafting or inoculating, if anybody would be so good a husband; and truly I never heard of any that did graft either plumb, nectarine, peach, or apricot in that country, before the first edition of this book [London, 1705].'

"In 1733 peaches grew plentifully in Georgia, as indicated by the following quotation:[2]

[1] "The History of Virginia," by Robert Beverly, a native and inhabitant of the place. Reprinted from the author's second revised edition, London, 1722. J. W. Randolph, Richmond, Va., 1855, p. 259.

[2] "A New and Accurate Account of the Provinces of South Carolina and Georgia." London, 1733. Said to be by General Oglethorpe. Reprinted in Collections of the Georgia Historical Society. Vol. 1, Savannah, 1840.

"'Mulberries, both black and white, are natives of this soil, and are found in the woods, as are many other sorts of fruits of excellent kinds, and the growth of them is surprisingly swift; for a peach, apricot, or nectarine tree will, from the stone, grow to be a bearing tree in four or five years' time [p. 50].'

"'They have oranges, lemons, apples, and pears, besides the peach and apricot mentioned before. Some of these are so delicious that whoever tastes them will despise the insipid, watery taste of those we have in England; and yet such is the plenty of them that they are given to the hogs in great quantities (p. 51).'

"In 1741 Sir John Oldmixon writes of Virginia:[1]

"'Here is such plenty of peaches that they give them to their hogs; some of them, called malachotoons, are as big as a lemon and resemble it a little.'

"In one of his chapters on the 'General State of Pennsylvania between the years 1760 and 1770,' Proud says:[2]

"'In some places peaches are so common and plentiful that the country people feed their hogs with them.'

"In 1795 Winterbotham writes:[3]

[1] "The British Empire in America," by John Oldmixon. Second edition, London, 1741. Vol. 1, pp. 440 and 515.

[2] "The History of New Sweden, or the Settlements on the River Delaware," by Israel Acrelious. Stockholm, 1759. Translated from the Swedish by William M. Reynolds, D. D., Philadelphia, 1876, being Vol. XI of the Memoirs of the Historical Society of Pennsylvania, pp. 151, 152.

[3] "An Historical, Geographical, Commercial, and Philosophical View of the American United States," etc., by W. Winterbotham. London, 1795. Vol. III.

"'The apples of this State [Maryland] are large but mealy; the peaches plenty and good. From these the inhabitants distill cider and peach brandy (p. 36).'

"'In some counties [of Virginia] they have plenty of cider, and exquisite brandy distilled from peaches, which grow in great abundance upon the numerous rivers of the Chesapeake (p. 84).'"

These abstracts and many other similar references made by Smith set forth the fact that the early development of peach-growing in America was practically coincident with the development of the colonial settlements following the landing of the Pilgrims in 1620, and that by the beginning of the nineteenth century peach trees were widely distributed from Massachusetts to Georgia. There appears to be evidence, in fact, that they were grown in Southern Canada at an early date. In 1748 Peter Kahn [1] writing under date of October 27 said, as quoted by Smith: [2]

"In the morning I set out [from Philadelphia] on a little journey to New York, in company with Mr. Peter Cock, with a view to see the country, and to inquire into the safest road which I could take in going into Canada." . . .

In a footnote, Smith states that:

"Later, when Kahn was in Canada, he notes the reported occurrence of peaches in the southern parts of Canada, and to the southwest in the Mississippi region, but makes no mention of having himself seen them in Canada."

[1] "Travels into North America," by Peter Kahn; translated into English by John R. Forster, F. A. S. Warrington: 1770, Vol. I.

[2] Smith, Erwin F., "Peach Yellows; A Preliminary Report." Div. of Botany, Bul. 9, U. S. Dept. of Agr. 1888, pp. 10–17.

Early records of peach-growing in Canada evidently are rare since the first note to come to the attention of the authors of a recent bulletin from the Ontario Department of Agriculture[1] bears the date of July 2, 1793. It is taken from the diary of one Mrs. Simcoe of Niagara, Ontario, and reads:

"We treated them with cherries, we having large May Duke cherry trees behind the house and three standard peach trees which supplied us last autumn for tarts and desserts during six weeks besides the number the young men ate." The next record here mentioned appears in the journal of a Captain Langslow who visited Niagara in 1817 and who spoke of peaches being "very plentiful." However, it was not until as recently as 1890, according to these authorities, that the planting of peaches became general in the province of Ontario, and apparently but few have ever been planted in Canada outside of this province.

Dating from the close of the eighteenth or early years of the nineteenth centuries, the planting of peach orchards of considerable size in different parts of the United States became more or less common, though the commercial orchard, as conceived of today, was an enterprise of later development. The planting of peach trees in Maryland a hundred years ago was doubtless typical of what was going on at that time in fruit-growing in other states. A few illustrations in this connection will suffice. The first large peach orchard in Maryland appears to have been planted by James Robinson about the year 1800.[2] It was located in Anne Arundel County some twenty miles south of Baltimore. This orchard

[1] Clement, F. M., and Harris, A. G. "Peach Growing in Ontario." Bull. 241, Ont. Dept. of Agr., July, 1916, pp. 1–2.
[2] Md. Exp. Sta. Bull. 72.

consisted of 18,000 to 20,000 trees, all of which were seedlings. Those were days of peach brandy, and the entire product of this orchard is said to have been used in making this commodity. Within the next few years several other small orchards were planted in the vicinity of Baltimore. It was apparently not until later that commercial orchards of importance were planted on the Eastern Shore of Maryland, but it is said that about 1830 an orchard of some 6000 trees was planted in Kent County, while about the same time one of 50,000 trees was planted in Cecil County along the Sassafras River, and from time to time others were put out at different points. Thus the industry developed, but commercial peach-growing in the modern sense, in eastern Maryland, appears to have been developed during the past fifty years, or since the Civil War. It probably reached its zenith during the years from about 1875 to 1890, after which for various reasons, but especially on account of the spread of "peach yellows," the industry declined. While there has been something of a revival of peach planting in this part of the country in recent years, there are some counties in eastern Maryland in which there are now practically no commercial orchards where once a traveler could hardly pass beyond the view of one or more. In large districts nearly every farm had its commercial peach orchard.

It would require many pages in which to write in full the history of peach-growing in America. The industry has been extended from time to time into new sections until there is now not a state — hardly a county — in which peach trees have not been planted. The development of peach-growing in each important section has its own story, in many instances it is a story of pluck and struggle and finally the realization of a vision that came to the mind of some enter-

prising personality. For the student of pomology, the history of the growth and development of such an industry holds a great fascination, but present purposes would not be served by following this course farther. Enough has been presented to show that the development of the peach industry has been practically coincident with the growth and development of the country itself since the beginning of colonial times.

CHAPTER II

ECONOMIC STATUS, AND EXTENT OF THE PEACH INDUSTRY

The peach is by far the most important of the "stone-fruits." Plums (including prunes) and cherries are next to the peach in the value of the crops in the United States, although these fruits fall far below the peach in this respect. According to the Thirteenth Census, the value of the peach crop (including nectarines, which are negligible) for 1909 in this country was $28,781,078; of plums and prunes, $10,299,495; and of cherries, $7,213,160. The apricot, the only other stone-fruit of commercial importance, for the same year, was valued at $2,884,119.

YIELDS

The peach crop for 1909, as reported by the Thirteenth Census, amounted to 35,470,000 bushels, of which more than one-fourth, or 9,267,000 bushels, were produced in California, with a value of $4,574,000. Georgia, the second state, both in yield and value of crop, produced 2,555,000 bushels worth $2,183,000. Though the yield in New York was under 2,000,000 bushels, the reported value was but little less than that of the Georgia crop. The yield for California in 1909 was about three per cent larger than the estimated average crop for the years 1909 to 1916, inclusive.

The estimated average crop for Georgia for the same period was in excess of 4,000,000 bushels, the annual extremes ranging from the maximum of 6,175,000 bushels in 1912 to a minimum of 1,950,000 bushels the following year. Other states of notably large average annual yields for this eight-year period are Arkansas, Texas, Michigan, and New York, in the order named. For these years, also, the estimated average yield for the United States was 45,714,000 bushels, as compared with 35,470,000 bushels for the Census year (1909), the annual range in the crop during the period 1909 to 1916 being from an estimated yield of 34,880,000 bushels in 1911 to that of 64,097,000 bushels in 1915. These figures serve to emphasize the variability of the crop from year to year in different parts of the country.

DISPOSITION OF THE CROPS

That the great bulk of the peach crop is used in the fresh state, a large proportion of it being shipped from centers of production to distant markets, is a fact too well recognized to require more than passing mention. There are many secondary ways, however, of utilizing the fruit, but only two of them are of sufficient importance commercially to call for attention here.

The drying of peaches has become a very important factor in California within comparatively recent years. While formerly a large number of peaches were evaporated in the eastern peach districts, the development of the dried peach industry in California introduced an economic situation which the growers in humid regions could not successfully meet. The fruit is sun-dried in that state. In humid regions the cost of the necessary fuel and evaporator equipment so in-

Plate III. — *Top*, atmospheric drainage shown by smoke drifting down a slope; *bottom*, a thin stratum of soil underlaid by a stratum of rock — a poor orchard site.

creases the expense of drying that profitable competition with the sun-dried fruit, in the absence of some compensating feature, is impossible.

The importance of this industry in connection with the California peach crop is indicated in the fact that for the five-year period 1912 to 1916 [1] there were dried in that state an annual average of 30,000 tons of fruit, or an equivalent of 120,000 to 150,000 tons of fresh fruit. During this period the output of dried fruit ranged from 23,000 tons in 1913 to 37,000 tons the following year. The size of the crop in that state, and the demand of the fruit for canning and shipping fresh, influence the quantity dried.

The second method of utilization referred to is canning.

The figures in Table I give some idea of the importance of the peach canning industry in handling the California crop:

TABLE I. — NUMBER OF CASES OF FREESTONE AND CLINGSTONE PEACHES CANNED IN CALIFORNIA IN DIFFERENT YEARS [2]

YEAR	NUMBER OF CASES		TOTAL
	Freestone Varieties	Clingstones	
1911	738,400	1,352,725	2,091,125
1912	583,800	1,630,255	2,214,055
1913	768,750	1,629,800	2,398,550
1914	888,125	2,621,655	3,509,780
1915	667,375	2,149,375	2,816,750
Average:	729,290	1,876,762	2,606,052

[1] *Calif. Fruit News*, Vol. 54, No. 1486 (Dec. 30, 1916).

[2] Figures from *Calif. Fruit News*, Vol. 50, No. 1381 (Dec. 29, 1914), and Vol. 54, No. 1486 (Dec. 30, 1916).

While canning is of considerable importance commercially in several states, California is far in the lead of any other in the quantity handled in this way. Many "freestone" peaches are canned, but by far the larger proportion of the output is is made up of "clingstone" varieties, which in some sections are planted especially for canning, as are certain sorts planted for drying.

Of the other states in which the canning of peaches is an important factor in handling the crop, Maryland is far in the lead, though falling much below California, as is evident from Table II, which follows:[1]

TABLE II. — NUMBER OF CASES AND VALUE OF CANNED PEACHES IN THE UNITED STATES AND IN CERTAIN INDIVIDUAL STATES PACKED IN 1909

STATE	NO. CASES CANNED IN 1909	VALUE OF CANNED PRODUCT
United States	1,467,213	$3,753,698
California	1,149,590	3,013,203
Maryland	80,489	158,839
Michigan	74,595	175,386
Georgia	71,931	156,282
New York	41,727	141,142

In no state, aside from those named in Table II, were there canned in the Census year as much as 8000 cases. There is much variation from year to year in the quantity canned in the different states. For instance, in contrast to the figures above given, there were packed in California in 1904[2] but 744,715 cases, while in Maryland 352,244 cases were canned — more than four times as many as were

[1] Figures from Thirteenth Census (Crop year 1909).

[2] Bur. of the Census Bull. 61, Census of Manufactures, 1905.

packed in 1909 — and in New York but 10,000 cases were put up as against more than 40,000 in 1909. On the other hand, in Michigan there was a difference of only a very few thousand cases in the two years.

A comprehensive survey of the economic status of the peach industry would require consideration of the capital invested in the orchards, packing-houses, and other equipment used in growing and handling the crop on the farm; the baskets, carriers, crates, and the like used in packing the fruit for shipment and their manufacture; the movement of the fruit from the point of production to the market, involving for a large proportion of the commercial crop long railroad hauls; the wages paid in connection with all these activities, including also the canning and drying of large quantities of fruit; as well, also, the financing and managing of other enterprises that are directly or indirectly concerned in the peach industry. But for the present purpose this partial enumeration of the features involved will suffice, even though there were available sufficient data (which there are not) on which to base a concrete consideration of these aspects. The investment represents many millions of dollars; the production and handling of the crop from the orchard to the consumer requires the annual expenditure of millions more.

DISTRIBUTION OF PEACH PRODUCTION

While detailed statistics regarding production are lacking for most countries, some idea of the wide distribution of the peach and its importance in the economic affairs of different peoples can be gained by such statistics as have been compiled. The following statements regarding peach-growing in different countries, aside from those relating to the

United States, are an epitome of a recent bulletin published by the United States Department of Agriculture.[1]

North America.

United States. — The most comprehensive statistical data available regarding peach-growing in the United States are those supplied by the Thirteenth Census (1910). There were then 94,506,657 peach trees of bearing age and 42,266,243 not of bearing age. Table III shows the five leading states on the basis of the number of bearing trees in each; also the number of trees in each of these states not of bearing age:

TABLE III. — NUMBER OF PEACH TREES OF BEARING AGE IN THE UNITED STATES AND IN THE FIVE STATES WHICH LEAD IN THIS RESPECT; ALSO NUMBER OF TREES NOT OF BEARING AGE

STATE	NO. TREES OF BEARING AGE 1910	NO. TREES NOT OF BEARING AGE 1910	TOTAL NO. TREES
United States . . .	94,506,657	42,266,243	136,772,900
Georgia	10,609,119	1,531,367	12,140,486
Texas	9,737,827	2,958,813	12,696,640
California	7,829,011	4,409,562	12,238,573
Arkansas	6,859,962	2,884,927	9,744,889
Missouri	6,588,034	1,404,429	7,992,463

It will be observed that on the basis of the total number of trees in these five states, the order would be changed somewhat, Georgia following California. On the basis of the number of trees not of bearing age the five leading states would stand in order: California, Michigan (which had approximately 3,000,000 non-bearing trees, this number

[1] Ruddeman, H. D., "Statistics of Fruits in Principal Countries." U. S. Dept. of Agr. Bull. 483 (Feb. 14, 1917), 40.

being slightly in excess of the number of bearing age), Texas, Arkansas, and New York (the latter with more than 2,200,000 trees not of bearing age).

There is no state in the Union in which peach trees do not occur, the smallest number reported by the census in any one state being 465 (including trees of all ages) in Wyoming. The interests are on a commercial basis in approximately thirty-five states, while in at least twenty-five of them they are of sufficient magnitude to form an important factor in the agricultural enterprises of those states. Moreover, there is much variation from one decade to another in the status of the peach industry in different regions. For example, in certain valleys in the Northwest there have been large peach interests, but the trees were planted mostly as fillers in apple orchards. As the apple trees have attained the age when they required all the space, the peach trees have been removed, certain centers thus ceasing very largely to be peach-producing points. In a similar manner, but for different reasons, the industry in districts in some of the older peach-producing states, where there were formerly extensive orchards, has been discontinued. For instance, in certain counties in eastern Maryland, where twenty to thirty years ago almost every farm had a commercial orchard, there is now practically no commercial peach-growing.

Canada. — The Census of 1911 reported 839,288 peach trees of bearing age, with a yield in 1910 of 646,826 bushels. Commercial peach-growing in Canada exists principally in the lake shore districts of the province of Ontario, which contain 794,192 trees of bearing age, leaving less than 15,000 trees in all other parts of the Dominion. In Ontario there were also reported 890,455 trees not of bearing age, thus making a total of 1,684,647 trees in that province.

Mexico, Central America, West Indies. — In some parts of Mexico, where the climate is temperate, peaches are grown to a limited extent but do not constitute any important commercial enterprise. In the subtropical and tropical parts of Mexico, Central America, and the West Indies, peaches are of only negligible importance.

South America.

Argentina. — No more recent figures are available than the Census of 1908 when 7,908,000 peach trees were reported. Buenos Aires was the leading province in the production of peaches, 32,017 acres, carrying 4,839,000 trees, representing the industry. They are also grown in a limited way in the regions of San Juan and Mendoza.

Chile. — No statistics available show the extent to which peaches are grown in Chile, but they are more or less widely planted. During the four years 1910–1913 the average annual production of dried peaches was 2,365,000 pounds.

Uruguay. — The peach is a relatively important fruit crop in Uruguay. In 1908 nearly one-half the acreage that was in fruits was devoted to peaches, or 33,418 acres out of a total of 68,125 in tree-fruits. The number of trees was 2,065,597 and the production 14,230,000 pounds. The peach is one of the principal fruits exported, the others being oranges, pears, olives, and cherries.

Peru.[1] — In some parts of Peru peaches are grown to a limited extent, but they are probably all produced on seedling trees and as a rule are of rather indifferent quality. Commercially they are unimportant except perhaps for very local markets.

[1] From notes by W. F. Wight. Bull. of the Pan American Union, Jan. 1914, p. 20.

In the countries in South America not mentioned peaches are grown, if at all, in such small quantities as to be a negligible factor in the fruit industry.

Europe.

Austria-Hungary. — Only fragmentary data regarding the extent of fruit-growing in this country are accessible. The average annual value of peaches exported during the period 1909–1913 was $13,000.

France. — The average annual production of peaches in France for the ten-year period 1904–1913 was 31,967 tons, or 1,332,000 bushels; for 1914 it was about 22,000 tons; and in 1915 about 15,000 tons.

Germany. — In 1913 there were reported to be in Germany 1,285,000 peach trees of bearing age and 735,000 not of bearing age. During the five years 1909 to 1913, Germany imported fresh peaches to the extent of an average annual value of $485,000, obtained mostly in Italy, and dried peaches and apricots, mostly from the United States, with an average annual value of $748,000. According to the Census of December 1, 1913,[1] there were in the several provinces of Prussia, peach trees in number as follows: in Silesia, 117,037; Saxony, 92,144; Rhine, 351,382; and in other districts not specifically designated, 495,595.

Italy. — The statistics showing the production of "stone-fruits" in Italy do not segregate the different kinds. The average annual production for the five years 1909–1913 of peaches, apricots, cherries, and the like was 117,000 tons: 126,000 tons in 1914 and 130,000 tons in 1915. For the years 1909–1913 peaches were exported in average annual

[1] Daily Consular and Trade Rept., Oct. 30, 1916, p. 390.

value of $559,000. A very large proportion of the fruit was shipped to Germany as above indicated.

Russia. — Considerable quantities of peaches are grown in some parts of Russia, but no statistics are available.

Turkey.[1] — No statistics are available, but according to the report noted they are grown in a limited way in the region of Constantinople, especially along the Bosphorus and the Marmora Sea. Evidently the climate is not unfavorable in some parts of Turkey for peaches; at least in 1911 more than 1,000,000 [2] pounds of dried apricots were exported. Doubtless, peaches could be grown wherever the apricot succeeds.

Spain. — The latest official figures, which are for 1910, show an area of 13,000 acres devoted to peaches, which yielded (supposedly in 1910) about 21,000 tons of fruit. For the years 1909–1913, peaches having an average annual value of $23,000 were exported.

United Kingdom. — About 93 per cent of the acreage devoted to fruit in the United Kingdom is in England. Peaches, however, in the limited extent to which they do occur are grown mostly in gardens and against walls. The peach is used but little in the United Kingdom evidently, since the average annual value of the imports of both apricots and peaches for the years 1909–1913 was barely more than $200,000.

Asia.

Japan. — The average number of peach trees in Japan during the five years 1909 to 1913 was about 6,330,000,

[1] Reported by Consul General G. Bie Ravndal, Daily Consular and Trade Rep., Dec. 13, 1915, p. 1020.

[2] U. S. Dept. of Agr. Bull. 483.

with an average yearly production for the same period of approximately 83,000,000 pounds. In 1914 the number of trees increased to 7,100,000 and the yield was 86,500,000 pounds.

Formosa.[1] — Peaches were not grown in Formosa (Taiwan) prior to the Japanese occupation, but since then they have been planted in limited numbers especially in the northern part. For the years 1910 to 1913, the number of trees ranged from 40,000 to 46,000; in 1914, it was about doubled. During these years the yield has averaged about 500,000 pounds annually.

Persia. — A wide range of fruits is grown in Persia which includes peaches, apricots, plums, dates, grapes, and oranges. The importance of the fruit industry is indicated by the fact that for 1909–1913 the quantity exported averaged annually more than 60,000 tons, valued at $7,000,000. No separate data for peaches are available.

Africa.

British South Africa. — Only fragmentary figures are available. These show the value of peaches exported in 1914 to have been $44,000.

Tunis. — No data on peaches are available. This fruit is enumerated in a list, which includes all the principal deciduous and subtropical fruits, as being grown there.

Oceania.

Australia. — Peaches are grown more or less widely in various parts of the Commonwealth. The average annual production of nectarines and peaches (these fruits are combined) for the season of 1912–1913 was 924,000 bushels.

[1] Huggins, H. C., Vice Consul, Daily Consular and Trade Repts., June 3, 1916.

In the foregoing sketch of the distribution of peach production, a general view of the importance of this fruit in the principal countries of the world is presented. No attempt is made to give minute details; the peach is of local importance in many regions that are not named in this enumeration, but so far as known those in which the fruit enters into commerce in any important way are included.

WHO WILL SUCCEED IN PEACH-GROWING

This is a very pertinent and wholesome question for the one who is beginning to consider the problem for himself. Not every one will succeed who plants a peach orchard, any more than does every one succeed who tries to run a bank, or to practice law, or to conduct a mercantile establishment, or to preach a sermon. The "personal equation" is a mighty factor in the economics of any enterprise or in any line of human endeavor, but perhaps in no other line more than in fruit-growing.

Commercial peach-growing is a highly specialized farm enterprise, and for one to succeed in it above mediocrity, he must possess the ability to become a specialist. The love of financial gain which such an enterprise is expected to return will not of itself be a sufficient inspiration to win success. The grower, in addition to this, must have some real aptitude for the work. Without it he is not likely to devote to the problems the continuous and intelligent consideration, the energy, foresight and good judgment that are essentials of success; or if he is thus able to bring into play sufficient acquired ability to attain in a measure the desired end, the work is only drudgery and his one reward is the accumulated profits, with but little joy in the process.

The answer to the question "Who will succeed?" is in the substance of the admonition given to a class of horticultural students by one of the best-known grape-growers of his time, in a state of large grape interests, when he said: "To succeed in grape-growing one must love his vines. He must feel that they are glad to see him when he goes into the vineyard in the morning and that they are sorry when he leaves them at night." With such a sentiment for his inspiration a peach-grower will gain satisfaction from his endeavor, which is more than financial gain, and it will help to insure the latter.

One is also to consider the location in which one lives, the soil, and climate. Success or failure may turn on the farm scheme, what part the peach crop shall occupy among other crops, how it is related to the subdivisions of the business, to the labor supply, to horse help, and to many other questions. Only rarely does it pay to grow peaches exclusively, as a separate business; even then, the business is full of risks. To the vast majority of peach-growers, the business must be only one part of a plan of farm management, utilizing much of the general capital and equipment of the place and footing up at the close of the year with the other farming enterprises.

CHAPTER III

LOCATION AND SITE OF THE ORCHARD

THE material success of a commercial peach orchard depends in a large degree on its location and site. The standard by which the success of a commercial orchard is measured is a money standard. Such an orchard is successful in the degree in which it yields the owner dollars and cents. A home orchard fulfills its purpose if it produces a supply of fruit for family use. The measure of success in this case is not that of financial gain.

It is not enough that a commercial orchard produces fruit, even abundantly and regularly, as it may be expected to do, other things being equal, if it occupies a good site. The location must be such that the fruit can be marketed or otherwise utilized to advantage. On the other hand, the location may be admirable, but the site so unsuited to the purpose that the trees fail to produce well. Either condition is disastrous according to the standard that a commercial orchard is successful in proportion to the financial profits that accrue from it.

While some factors are common to both location and site, others are peculiar severally to each. The location is general. It is the place of an orchard on the map. It concerns the relation of the place to natural objects such as mountain ranges, valleys, or bodies of water; and to the town, the

shipping station, the transportation facilities, and incidentally to the markets. The location of an orchard is its geography.

The site is specific. It has to do with the exact spot on the farm occupied by the orchard — the land on which the trees are planted.

All over the country wherever peaches are grown, there are orchards (and many, of which the epitaphs have disappeared entirely) that tell the sad story of poorly chosen locations and sites. Not infrequently orchards are planted and cared for with all due regard to the essentials of good management, only to demonstrate in later years that faulty location or site or both make success impossible. Thus, it follows that the future of an orchard is determined in no small way by the wisdom and discrimination exercised preliminary to the actual beginnings of the enterprise. The factors having to do with the selection of locations and sites call for further consideration.

LOCATIONS FOR PEACH ORCHARDS

Locations should be chosen with reference to the geographical range of the species, the climatic conditions which obtain, their accessibility to the markets, the community interests, the economic conditions, and in many instances the sequence in which the varieties one desires to grow will ripen in comparison with those shipped from other locations or regions and with which competition may be experienced.

Locations with reference to range of the species.

The peach is distinctly a temperate-zone fruit and within that zone in its numerous varieties it has a remarkably wide

range which in North America extends from southern Canada in the region of the Great Lakes and in British Columbia, on the north, to Florida, southern Texas and even into the higher elevations in Mexico, on the south, and from the Atlantic to the Pacific oceans. However, within these geographical boundaries there are many limitations and restrictions that rather definitely fix the local distribution. The most potent limiting factor is climate, of which temperature is the most important element. The cold of winter limits extension northward, while the heat of the subtropical sections limits the extension southward, and in parts of the western Great Plains area the limiting factor is a combination of moderately low winter temperatures, a scanty moisture supply, and sometimes desiccating winds.

Locations with reference to climatic conditions.

The one leading question habitually asked by the prospective but inexperienced peach-grower, when considering a location, is whether the soil is adapted to peaches. This is asked in the belief that if only the soil is suitable, the fitness of a location for the purpose is settled. The soil is important with regard to the site, but not fundamentally so with regard to location. The climate is the primary factor, so far as growing the fruit is concerned.

The general facts have been stated. Further amplification will serve to call attention to other important considerations that are more or less local in their application.

Unfavorable temperature conditions are represented by different extremes. A region in which the winter minimum is 20° below zero is too cold for peaches when the object of the planting is financial gain. The fruit-buds would be killed too often for an orchard so located to be profitable.

PLATE IV. — An orange tree injured by a freeze and which shows the stratification of the air according to temperature.

In fact, when the temperature drops lower than $-10°$, commercial peach-growers begin to speculate on the chances of a crop the coming season. On the other hand, one frequently hears of a peach tree passing through a temperature of 30° below zero or perhaps even lower and still producing some fruit the next season. The condition of the tree at the time such extreme temperatures occur determines to some extent the results. If the buds are perfectly dormant and the trees vigorous and thrifty, the effects of an adverse temperature are much less serious than when opposite conditions of tree and buds prevail. Moreover, a menacing temperature may cause little or no damage to the buds if its period of duration is short, when at another time a temperature even less severe will cause great loss if it lasts for a considerable length of time. It may be noted that in case of injury, the fruit-buds are the first to be affected. The tree usually will withstand without injury considerably lower temperatures than the fruit-buds.

In contrast to locations that are limited by too great cold in winter, those limited by subtropical temperatures require mention. While the varieties of certain races of peaches can be grown where the climate is very mild all the year, they do not thrive where it is not sufficiently cold, for a short period at least, to induce a dormant condition. Thus it follows that the southern extension of peach-culture, as well as the northern, is limited by temperature, but by the opposite extreme.

Even more important, perhaps, than either of the extremes of temperature mentioned is a combination of comparatively mild extremes at certain periods. For example, in certain sections of the country, including some in which large peach interests have been developed, very mild spells

of weather are apt to occur in January or February, alternating with periods of seasonable winter weather. So long as the latter continues, the peaches are safe, but with the occurrence of the warm spells the buds swell enough to become tender and are killed later by lower temperatures which are not unseasonable, and which would cause no injury with the buds in a dormant state. The loss or partial loss of crops from this combination of temperature conditions is more serious, perhaps, in the southern peach districts than is the loss from extremely low temperatures in the northern districts, and in which disastrously warm periods in winter rarely occur.

Another factor of temperature that sometimes causes great loss to peach-growers is late, or untimely, spring frosts that occur during the blossoming period. Some regions are rendered unfit for commercial peach-growing by the frequency with which the blossoming period of the trees and the occurrence of killing frosts coincide. Otherwise, good crops of fruit could be produced in them with reasonable regularity. Regions having low altitude, or level topography, either of which may presage poor atmospheric drainage, and in which the climatic conditions commonly induce early blossoming, are very apt to be poorly adapted to peach-growing for the above reason. Obviously a prospective peach-grower in seeking a desirable location should aim to correlate the spring frost factor with the average blossoming dates of peaches in any locality that he may consider. If it is found that in a locality the average date of last killing frost in the spring occurs during or after the average dates of blossoming of peaches, it becomes apparent at once that frequent loss of the crops might be expected should an orchard be planted there, unless it oc-

cupies a site less subject to frosts than the general average of the region.

It is true, of course, that practically all the important peach-producing regions suffer losses from time to time from adverse temperatures. The fruit-buds are killed by an exceptionally low winter temperature, or as a result of an unusually warm spell during which the buds start enough to become tender, or by a frost or occasionally even a freeze that comes after the trees are somewhat advanced in the spring. Sometimes even a snowstorm may come when the trees are in blossom. This, however, may prove fortunate in case of a freeze. If the blossoms are full of snow when the freeze occurs, it practically insures a very gradual thawing of the frozen parts, and under this combination of conditions enough buds may escape injury to make a profitable crop of fruit. If, in addition, it remains cloudy until thawing is completed, surprisingly little injury may actually occur.

A location having a relatively high elevation is generally to be preferred to one having a low elevation. This factor has special significance, however, with regard to selecting a site and it is considered at greater length under that topic.

In further consideration of the climate in its relation to suitable locations for peach-growing, reference needs to be made to the influence of large bodies of water on local climatic conditions. However, to have an appreciable effect, not only must the area of such bodies be large but the water must be deep. Because the water warms up in the spring more slowly than the atmosphere, it acts in effect as an immense refrigerator, making the temperature in its immediate vicinity colder than it is at points somewhat distant from

it. For this reason, vegetation within the zone of this influence advances more slowly in the spring than it does outside of it. The tendency, frequently very marked, is for the blossoming of peach trees situated within the zone to be delayed until after the season of spring frosts is past.

In the fall, frosts are delayed in a similar manner, except that the large body of water, having absorbed much heat during the summer, cools off more slowly than the atmosphere, and hence tends to keep the temperature within its zone of influence warmer than it would otherwise be. In some cases the winter temperatures are also modified by large bodies of water, even though they may be frozen over for long periods.

It is because of these reasons that peaches are grown with marked success, and injury to the crops by adverse temperature conditions is comparatively infrequent in the parts of New York and Ontario that border Lake Ontario; in Ohio along Lake Erie; in southwestern Michigan on Lake Michigan; and in some other districts which are adjacent to large bodies of water. As a rule, the zone of influence of bodies of water, such as those named, is rather narrow, usually not extending back from the shore more than a few miles. However, the topography, and especially the degree of the slope of the land from the water, determines very largely the extent of the area affected thereby.

A striking illustration of the ameliorating effect of water is in the difference in the winter temperatures that prevail on opposite shores of Lake Michigan. One of the most regularly successful peach-growing regions in the United States is a narrow belt along the lake shore in western Michigan, the belt extending as far north as Grand Traverse Bay. The winter temperature in this belt rarely drops much be-

low zero, while on the opposite side of the lake in a corresponding zone in Wisconsin peach-growing is prohibited by the severity of the winter temperatures. The difference is in the ameliorating effect of the water, which never freezes over entirely, on the cold winds that sweep over it from the North and West and which are unmodified as they reach the Wisconsin lake shore.

Locations with reference to accessibility of markets.

The advantages that come from a location that is in rather close proximity to a shipping station do not need to be enumerated to become apparent. Such a location is not only desirable but it is essential. Moreover, the restrictions in this regard are rather narrow. A haul of four or five miles from the orchard to the shipping point has usually been about the limit in the past and unless the roads over which the fruit must be hauled are much better than those in the country commonly are, the cost of delivering the fruit to the station might represent an expense which would cut seriously into the profits and which would place the owner under a tremendous disadvantage in comparison with an orchard located within a short haul of the station or loading switch.

Of course, where a peach-grower sells his fruit in a local market, and personal deliveries are made so that the cost of the haul represents the entire transportation charge, a greater distance than four or five miles from the orchard to point of delivery may not be impracticable, with good roads, although distance is a great consumer of time and not infrequently it is the limiting factor in marketing operations. Even short hauls over poor roads are likely to prove ruinous to the fruit.

The coming of the auto-truck and improved roads tend to eliminate distance as a factor, so that where both the auto-truck and good roads can be combined, much longer hauls to local markets and to shipping stations are not only possible, but much more practicable than formerly.

For most locations, accessibility of markets is measured by the character of the transportation facilities available rather than by the distance in miles between points of production and the points where the fruit is marketed. Deliveries to remote markets may be made in a shorter time where the routes are direct than is possible where the distances to be covered are much less but transfers to several different railroads are necessary.

If a location is served by more than one line of railroad, it is usually advantageous to the shipper, whether the different lines are competing or make accessible important markets that could not be reached readily with a single line. Locations that have both water and rail transportation are likewise situated fortunately in many cases with regard to placing perishable products quickly on the market.

In numerous instances the development of peach orchards (as well as other fruit interests) has followed the building of railroads through a section of country, and there are still countless locations which are no doubt as well suited naturally to peach-growing as those in which such enterprises have been developed but which are not available for this purpose in the absence of adequate transportation facilities.

Locations with reference to community interests and economic conditions.

Community interests may also be important in the success of a peach orchard. If the orchards are com-

paratively small, the individual growers may be unable to load entire cars at any one time, whereas it is possible for a community of growers to eliminate the necessity of express or broken car shipments. And further, a community or locality in which there are large peach interests attracts more fruit buyers and sometimes, doubtless, more expert laborers. The possibility of organization and coöperation among the growers for mutual benefit in selling the fruit and in purchasing supplies offers very definite advantages in many respects which cannot be realized where the orchards are isolated with regard to one another.

In locating an orchard, it should be anticipated that during "peach season" a relatively large number of laborers are required to pick, pack, and handle the crop. The grower should see to it before the location is finally determined on that the community affords ample facilities for taking care of the laborers, or else arrangements for housing and providing for them at the orchard should be included in the initial plans of development.

Locations with reference to the ripening of the fruit.

The factor here involved is economic rather than pomological in its significance. While many varieties of peaches are in cultivation, there is probably no other fruit industry with wide geographical distribution that is built up so largely on a single variety as is the peach industry at the present time. In practically all peach-growing districts in the United States, with the exception of those in California in which a number of different varieties are grown for special purposes, and in the extreme South where a subtropical climate restricts the choice of varieties, the Elberta has come to be by far the most extensively planted of any variety. In

many sections earlier varieties are grown to a limited extent and in others both earlier and later sorts are grown. However, with but comparatively few exceptions other than those noted, the main crop consists of the Elberta and as this variety comes "in season" in its progressive sequence northward, it virtually marks the end of the "peach season" for the year in the more southern districts. In the practical working out of the matter, the profitableness of peach-growing in any location depends in no small measure on the sequence in which the Elberta peach ripens there in comparison with its ripening period in other localities with which it comes in competition in the markets. Thus, a location in which the variety or varieties planted ripen during a period when the markets are already fully supplied with fruit is not likely to prove as satisfactory from a financial standpoint as one in which the fruit ripens at a time when the markets are not overstocked with fruit from other districts. This factor is of much greater importance than is sometimes supposed. Of course, something depends in this connection on the selection of varieties. A grower is not restricted to the Elberta, but its wide range of adaptability and its excellent shipping qualities are apt to give it first choice in the average commercial orchard.

The accompanying illustrations, which show typical peach orchard locations in different parts of the country, serve to emphasize some of the important factors that have been presented under this topic.

Plate I (Frontispiece) shows an orchard located in the Alleghany Mountains. The location is representative of a large region in which extensive peach interests have been developed within the past twenty years. The elevation of the mountain ridges insures good atmospheric drainage, and the rolling,

broken topography of the individual sites is favorable to the same end. In most of this region the land has been cleared expressly for the planting of the orchards. Plate II shows a region similar in much of its local topography to that in Plate I. It is a foothill location in California. Though the topography is much broken, the orchards are irrigated.

These two illustrations are typical of the mountain peach districts of the country which, because they possess in a high degree the essential features of good locations, have proved admirably suited to peach-growing.

ORCHARD SITES

An orchard site is the very piece of land on which the trees are planted. The site has to do chiefly with the soil, topography, elevation (relative rather than actual, though both may be important), and local climatic conditions. Obviously, some of the "location factors" are also "site factors." In the latter connection rather detailed consideration is needful.

Soil.

It is current opinion that peaches should be planted on sandy or some of the lighter types of soil. It is doubtless true that such types largely prevail in some of the most important and most successful peach regions, and that fruit of remarkably high quality and color is commonly produced on such types. It is likewise true that peach trees thrive and produce good fruit on a rather wide range of soil types, including some of the gravels, shales, loams, and even the clays, if they are not so heavy and impervious as to be poorly drained. However, soils that induce an extremely heavy

growth of wood and foliage are apt to be objectionable because these results are not always conducive to the production of the best crops, nor of fruit of the highest quality and appearance. It is doubtless a fact, fully supported by experience, that the well-drained warm soils preserve the best balance between vegetative growth of tree and fruit production. It obviously follows that such soils usually represent the lighter types. The heavy types are likely to lack adequate drainage.

In addition to the type as indicated by the surface, the subsoil is of the very greatest importance — greater even than that of the surface. The surface may have every appearance of being a good "peach soil" and yet the subsoil be of such a character as to make the site quite impossible for the successful production of peaches. For instance, a thin stratum of soil underlaid by rock, as is shown in Plate III, makes a soil condition entirely unsuited for orchard purposes. Under the most favorable moisture conditions, an orchard planted on such a site may do well, but in times of severe drought it is likely to suffer because the reservoir of soil-moisture is so limited; in times of excessive rains, difficulties resulting from poor drainage conditions are likely to occur. Many orchards have failed because the soil stratum above a hard pan or solid rock was too thin.

The surface soil can also be modified considerably by the way in which it is handled, but the subsoil admits of only slight, or even no modification, by ordinary means, except perhaps as it may be changed by drainage, or by the growing on it of deep-rooted plants such as alfalfa.

If the subsoil is very gravelly and porous, it is likely to feel severely the effects of even moderate droughts and be unsatisfactory on this account. The other extreme — a

heavy clay subsoil — is likely either to be poorly drained or so retentive of moisture as to induce a stronger growth of wood and leaves than is desirable.

A soil, whatever the type, must be thoroughly well drained, yet not droughty. It needs to be well supplied with humus, otherwise its physical condition will be impaired, it will be quickly affected by drought, and its fertility reduced below an effective standard. Moreover, a soil should be moderately fertile. One excessively rich in nitrogen is not to be desired as a general rule, since it is likely to induce a superabundant growth of foliage. On the other hand, the impression which is somewhat common that a poor, unfertile soil is "good enough for peaches" is erroneous. In districts where alkali soils occur, sites should be selected with a view to avoiding them. While peach trees will withstand a very limited amount of alkali salts in the soil, they cause disaster if present in large quantities. It is safer, therefore, to avoid them entirely.

Topography, elevation, slope, and local climate.

While each of these factors has its individual bearing on the problem and each is fundamentally important in selecting an orchard site, their influences on the prevailing conditions are so interrelated that they need to be considered together.

With the soil problem settled, the outstanding requirement in choosing a site for a peach orchard is good atmospheric drainage. It is often of greater importance even than the soil on account of its relation to freedom from spring frosts. That air of a given temperature is heavier than air of a higher temperature is a most familiar fact. For this reason cold air settles to the lower levels and frosts form in "bottom lands" when higher up on the slopes above the

"bottoms" none occurs and perhaps tender vegetation is green for days or even weeks in the autumn after all but the hardiest plants in the low places are dead from frosts.

The stratification of air according to its temperature is visualized in a remarkable manner in Plate IV. It shows an orange tree injured by a low temperature in December, as it appeared the following February. It is well known that when green foliage is entirely killed by a sudden and very severe freeze or frost, it will dry up on the tree and may cling to it for a long time; whereas a temperature that is barely low enough to kill the foliage will result in the leaves dropping at once. These conditions are indicated in Plate IV. The leaves on the lower branches were so severely frozen that they dried up and remained on the tree. The stratum of air having this severe temperature apparently extended from the ground to a level just above the height of a man's head. In the middle section of the tree, the temperature was low enough only to cause the foliage to drop, while at the level of the upper third of the top no injury is apparent. Thus, within the height of the tree there were strata of air having three different temperatures, each resulting in a different expression in terms of tree life. In reality these results were due directly to differences in elevation.

The same expression is indicated in Plate III. The orchard is situated on the slope of a mountain ridge. The illustration was made early in the morning when there was no wind, but a current of cold air settling down the slope to a lower level is carrying with it the smoke from a burning stump.

Attention may now be called to the fact that topography refers to the general conformation of the surface. In reference to orchard sites, it has to do with the physical fea-

PLATE V. — An orchard site in east central Georgia; the topography is more or less rolling; the elevation about 500 feet.

tures of the land. Sites where the topography is rolling and broken, as those suggested in Plates I and II, have better air drainage and sometimes better soil drainage than where the topography is level as suggested in Plates V and VI. There is no lower level into which the cold air can drain from these sites. The topography of the sites in these two illustrations is similar, though the elevations above sea level and the general locations are very different. Plate V shows an orchard site in the east central part of Georgia where the elevation above sea level is about 500 feet; Plate VI, a valley orchard in Colorado with an elevation of about 5000 feet above sea level.

It needs to be emphasized that a high elevation above sea level in itself does not signify good atmospheric drainage. The relative elevation of the site compared with the surrounding area is of real importance.

From the standpoint of good air and soil drainage, sites along the slopes of mountains where the contours are regular as in Plates III (*top*) and VII (*bottom*) are ideal, except the steepness of the slope which makes tillage, spraying, and other orchard operations difficult and more expensive than where the site is more nearly level. Extremes in steep or broken topography need to be guarded against. While a topography like that shown in Plate VII has its objections, the soil and subsoil are of such character that erosion does not occur. Many types of soil would wash irretrievably under such conditions, and where the surface is too uneven the inconvenience in carrying on necessary orchard operations is excessive. Therefore, although a broken topography is much more to be desired than a dead level, for reasons given, there is a limit in this direction beyond which the disadvantages more than equal the advantages.

Other sites suggestive of good local atmospheric drainage are shown in Plate VIII. These orchards are in a valley location in Colorado where plantings have been made on small mesas at three or four different elevations above the floor of the valley. In the light of the foregoing discussion, it is apparent that frosts might do serious damage in the lower orchards while those on the higher mesas would escape entirely.

It remains now to state that both topography and elevation in their relation to orchard sites are expressions primarily of very local, though often very potent, climatic differences. If an orchard site having a relatively high elevation produces more regularly than one with a lower elevation, other things being equal, it is because of the local climatic differences which are incident to the different elevations. Thus it is that the elevation factor is fundamentally a climatic factor in its relation to orchards.

Where the topography is greatly broken, much care and wise discrimination are necessary in selecting orchard sites because of inequalities that may not be apparent on the surface. Sites such as those shown in Plates I and II are likely to have "pockets" into which the cold air will settle, or the soil may vary widely and be unsuited in some places for orchard purposes, or for other reasons the problem of site selection is likely to be more complicated than where the topography is uniform.

Emphasis has been placed on the importance of relatively high elevations, and in recent years their advantages in comparison with elevations that are low in relation to surrounding areas have been repeatedly and unequivocally demonstrated by the frequent frost injuries in orchards situated on the latter in contrast with the infrequent injury where

orchards have been relatively high. Yet there are exceptions under certain conditions, though these do not in any degree affect the prevailing preference for the higher elevations.

Sometimes in periods of rather intense cold that are accompanied by high winds, the fruit-buds will be killed at the higher points and escape injury at the lower places.

Another condition due to the modification of temperature by elevation is suggested by what occurs repeatedly in the orchard shown in Plate VII. The orchard extends to the crest of the ridge, which is about 2100 feet above sea level. The lower side of the orchard drops below the crest 400 or 500 feet, while the floor of the valley is several hundred feet below the orchard. While the cold air obviously drains from the orchard to the floor of the valley and during the winter and early spring the temperature in the valley is doubtless lower than at any point on the part of the slope occupied by the trees, the warmest zone is evidently somewhere between the orchard and the valley floor. Not infrequently the trees in the lower part of the orchard blossom two or three days earlier than at the upper side and there is a corresponding difference in the ripening of the fruit in some seasons. Thermometer records made at different elevations along the slope show consistent temperature differences that correspond with the behavior of the trees.

These phenomena might at first appear to contradict the statements made above in regard to the importance of relative elevation in orchard sites. They are in perfect harmony, however, with the well-known fact that above certain limits of elevation the air becomes increasingly colder until the line of perpetual snow is reached in the higher mountains, even though a tropical or subtropical climate

may prevail in certain zones farther down towards the valley. This line of reasoning applied to the orchard in Plate VII suggests that were the mountain on which the orchard is located some hundreds of feet higher, a limit of elevation would be reached where the temperature factor would preclude the growing of peaches and which would not be counteracted by atmospheric drainage.

Yet another factor of some importance is slope or aspect — the points of the compass towards which the site inclines. The preferred slope for a peach orchard has been much discussed, but cannot be settled in any dogmatic manner. The question admits of no direct answer. No one slope is preferable under all conditions and in all regions. In fact, the influence which a particular exposure may have in the success of an orchard is probably much over-emphasized in the popular mind.

As a rule, it is doubtless safe to assume that a site having a moderate slope in some direction is to be preferred for orchard purposes, other things being equal, to one that is level. One having a slope will usually have better drainage of soil and atmosphere than a level area; but so far as these factors are concerned in the abstract, one slope may be as good as another.

An orchard that occupies a site which slopes away from the prevailing wind may be afforded a certain amount of protection therefrom in some cases, and in some regions there are well-marked soil differences on the different slopes of the ridges. These differences may be such as to make one slope better adapted to peach-growing than another.

Probably in the minds of most fruit-growers the chief difference between the slopes in their relation to fruit-growing is assumed to be a matter of temperature. That differ-

ent slopes may have different temperatures seems to be made evident in the common observation in many peach districts by the rapidity with which snow melts on southern slopes in comparison with corresponding northern slopes. But this evidence is at the surface of the ground. A few feet above the ground, where the air has perfectly free circulation, the difference in temperature that may exist at the surface on two opposing slopes, if they are not too steep, largely disappears. Hence, the tops of the trees on different slopes may be in essentially the same temperature even though there are appreciable differences at the surface of the ground. However, the slope factor is largely one of degree, so far as it requires consideration in selecting orchard sites. Peach trees on a site having a very steep southern slope will usually blossom and the fruit will ripen somewhat earlier than on a corresponding northern slope, but where the differences in slope are only moderate their relative influence on the time of blossoming and ripening is not very marked. Whether early or late blossoming is desirable is largely a local matter and depends primarily on the relative dates of blossoming and the usual occurrence of spring frosts in any locality or on any site. The slope is, therefore, fundamentally but another factor which goes to make up local climate.

The local climate of a site may be influenced at times or perpetually modified by still other factors. Its slope with reference to the prevailing winds, the presence of shelter belts, windbreaks, or natural barriers such as mountain ranges, may have a modifying influence and where they occur should be taken into account in selecting a site.

The best site, other things being equal, is the one where the natural conditions are so combined in their favorable

influence on the orchard that the latter produces abundant crops with the greatest degree of regularity. An orchard that is moderately but regularly productive, in the long run, is much to be preferred to one that produces great crops at irregular intervals.

CHAPTER IV

PROPAGATION OF PEACH TREES

THE growing of nursery stock is a business quite distinct from that of orcharding. While some nurserymen grow fruit and some orchardists also produce nursery stock, the average fruit-grower will usually find it to his advantage to purchase his trees from one who is a specialist in the art of growing them rather than to propagate his own. He will usually obtain better trees thereby, and in the end probably they will cost less. However, the fruit-grower ought to have a general knowledge of nursery methods and practice, even though he may not want to use that knowledge in the actual production of trees. He will be the better able to handle his trees if he knows how they are propagated. Moreover, it will enable him to judge better the grades and standards of the nursery stock with which he has to deal.

The methods by which peach trees are usually propagated are simple, yet they involve many details requiring careful attention. The disregard of any one of them may prove extremely costly in the results. Propagation is almost universally by budding on seedling stocks, the ordinary "T" or shield-bud method being used. The various steps in the operation from the growing of the stocks on which the buds are placed until the trees are ready for delivery is concisely described in the following paragraphs.

STOCKS

Peaches are most commonly propagated on their own roots, that is, on peach seedlings, and under most conditions this is probably the best method. However, in some regions, particularly in California, other stocks have been used to some extent, it being claimed that the hard-shelled almond produces a hardier, stronger tree, especially for growing where the soil is very light and dry, than when propagated on peach stocks. Formerly St. Julian and Myrobalan plum stocks were used to some extent in California. They were supposed to be better than peach stocks for planting on soil that was excessively moist. However, the peach top is likely to over-grow the plum root and to develop a weakness at the point of union. For this and possibly other reasons, plum stocks are not now much recommended.

Recently still another species has been receiving favorable comment as a stock for peaches and some other stone-fruits. This is the "wild peach of China" (*Prunus* or *Amygdalus Davidiana*), seed of which in some quantity was introduced into the United States from China in 1907 by the Federal Department of Agriculture, although it was grown in this country before that date. The following note relates to the behavior of the plant at the Michigan Agricultural College in the winter of 1887–1888: "*Prunus Davidiana* endured the winter without injury so far as the wood was concerned, but the flower-buds, of which there were many, were all killed. A plant wintered in a shed blossomed profusely April 28th, a very early date this season. If the tree had been out of doors, where it must have bloomed earlier, the flowers would have been nipped by frost. All the flowers on the tree in question were imperfect, the pistils being

undeveloped." These earlier introductions need not be further considered as they apparently have no relation to the use of the species for stocks.

This peach (*Prunus Davidiana*) is an excellent stock to bud, as it "works" very easily and is not especially sensitive to climatic changes during the summer; that is, the bark does not set during ordinary periods of drought; it is a strong grower in some sections and trees propagated on it make a vigorous growth when young, though it appears to have a slight dwarfing effect on the ultimate size of the tree. Moreover, it occurs in China where it seems to be in a high degree resistant to drought and alkali.

Sufficient time has not yet elapsed since this species was first used in this country as a stock to determine whether the trees will develop weaknesses with age that are traceable to the stock, nor has its range of adaptability yet been determined. There are other problems connected with its use, but thus far favorable as well as unfavorable results have been widely reported. The unfavorable results have been due evidently to the stock not being adapted to the conditions where grown. This emphasizes the necessity of carefully determining its range before it is used commercially.

The Sand cherry of the West (*Prunus Besseyi*) has been used in a very small way as a dwarfing stock, but its real value and practicability as such are not yet determined.

The use of peach seedlings in propagating peaches so largely predominates that the handling of them alone will be given consideration in the further discussion of peach propagation.

Peach pits, or seeds, for use in growing stocks are obtained mainly in two ways: from canning factories and from "nat-

ural," that is, seedling, peach trees and orchards that abound in the Appalachian Mountain districts and adjacent areas of North Carolina, Tennessee, and certain other states. The latter source is usually considered much the more preferable. Pits secured at canneries may have come from fruit produced on "diseased" trees — the disease most feared being "peach yellows." However, this disease has not reached the Pacific Coast so far as known, and no serious difficulties appear to follow the use of pits from canneries in this part of the country. Pits of certain varieties, such as the Salwey, are generally preferred. It may here be said that pits from fruits that definitely show "yellows" will very rarely germinate; this may not apply, however, to pits from fruits grown on the apparently healthy part of a tree that is just beginning to show this disease on a part of its limbs.

For many years the seedling peach orchards above referred to as growing in some parts of the South have been favorite sources for peach pits from which nurserymen have grown their seedling stocks. The pits are gathered in the late summer and early fall, frequently a bushel here and a half bushel there, or in larger quantities as conditions may permit, assembled at central points, as at a country store, and subsequently taken over by nurserymen or others who make a specialty of supplying peach seed to the nursery trade.

The advantage claimed for the natural peach pits over those from "budded varieties" is smaller size, greater uniformity in size, thus making machine planting easier and more satisfactory, and also a greater uniformity and vigor in the seedlings that grow from them in comparison with those from cannery pits. Besides, the best grades of natural

pits run about 7000 seeds to the bushel, while those from budded trees may drop as low as 2200 to the bushel on account of their larger size.

In planting the pits there is wide variation in the practices of different nurserymen and in different sections. Perhaps the simplest method is when the pits are planted in the autumn in drills where it is intended to grow the nursery trees. When this is the case, the site needs to be selected with discrimination. A thoroughly well-drained site is essential; the soil needs to be abundantly supplied with humus, and fertile, otherwise the trees will not make adequate growth. A heavy soil is objectionable, as is usually a very sandy one. Moreover the soil must be deep, else the roots will not develop well. The drills are usually placed $3\frac{1}{2}$ or 4 feet apart. The pits may be dropped by hand 6 or 8 inches apart in shallow furrows that have been opened to receive them or the dropping may be done with a peach-pit-planter — usually so constructed that it will drop two rows at once. The quantity of pits used to the acre may vary from 7 or 8 bushels to a much larger amount, depending primarily on the size of the pit. The usual type of peach-planter will drop 150 bushels a day of the smaller sized seed.

The pits are planted about $1\frac{1}{2}$ or 2 inches below the level of the surface. In covering, when planted in the fall, especially in the North, the rows are commonly ridged slightly so that the pits are covered with about 3 inches of soil. In the spring the ridges are leveled down, leaving the pits covered with 2 inches or a little less of soil.

The moisture in the soil aided by the freezing (in the colder parts of the country) will crack the pits during the winter and early spring, and with the return of the growing season the kernels will germinate.

There are still other methods of handling the pits. One of the more common ones is to "bed" them either in midsummer or in the autumn. If in the summer, it presupposes that the supply of pits was procured the preceding season. The current season's crop of pits would not then be available.

Bedding is done about as follows with such individual variations as different nurserymen may make: A well-drained site for the bed is selected, where an excavation 12 or 15 inches deep is made. A convenient width for the bed is about 6 feet since the center can then be reached readily from either side; the length to correspond with the quantity of pits to be bedded. Then the pits are mixed with a liberal proportion of moist sand and filled into the bed, where they are finally covered with 3 or 4 inches of sand. Or, instead of mixing the pits with sand, the pits and sand are placed in the bed in alternate layers about 2 inches thick and finally covered with several inches of sand, as described above. This is commonly called "stratification" of seeds. It is a method used in handling many kinds of seeds and nuts.

The bedding of the pits may be done in the fall instead of in midsummer. Whatever the details thus far, the seeds are left in the bed until the next spring. The moisture and the freezing during the winter will crack the pits the same as when they are planted in the autumn where they are to grow.

With the return of the "planting season" the next spring, the kernels are separated from the pits and sand by sifting or otherwise, and are then planted in drills and covered from 1 to 2 inches deep.

The advantages for bedding over fall planting are that

the conditions are under control in the bed, and a more uniform cracking of the pits may be secured. The kernels being brought to view, the planting can be governed by their condition and quality rather than by the appearance of the pits alone. If many of the pits contain imperfect kernels, it becomes evident and the planting can be gauged accordingly. Thus it may be possible to secure a better stand of seedlings by the stratification method than by planting the pits in the fall where the seedlings are to grow.

The foregoing methods, or some incidental modifications of them, are followed in the regions where the winter temperatures are sufficiently low to freeze the pits, either when stratified or planted in the autumn, the freezing aiding in separating the pits along the sutures.

In the South, however, where mild winter temperatures constantly prevail, peach pits are commonly planted in September or October where the seedling stocks are to grow, in the same manner as when planted in the fall in the North. Or the seeds may be stratified in a bed with sand in about the same way as in the North, but special attention is given to keeping the bed moist, since the cracking of the pits is dependent on the moisture alone without assistance from the freezing, which is of very material aid in the colder sections.

In the course of several months, usually in January and February, the pits will begin to crack open as a result of the continuous influence of the moisture which surrounds them. As soon as they crack in considerable numbers, they are separated from the sand and planted as already described.

Other southern nurserymen plant the pits in October where they wish the seedling stocks to grow. However,

many of the pits, when handled in this manner in warm climates, do not crack the first season, hence do not germinate. Therefore, the usual course by this method is to plant the seeds more thickly than when planting kernels that have been separated from the pits with a view to using the first season's seedlings the summer following the planting; then by the second spring the seeds that did not grow the year before will germinate. Thus two successive crops of seedlings are grown from the one planting and accordingly two successive crops of nursery stock are produced on the same piece of land.

Thus it follows that, contrary to common belief, freezing is not a necessary agent in the cracking of the pits, but if they are soaked a sufficient length of time (it may require several weeks or even months to soften them at the suture if they are extremely dry and for the kernels to become so plump from the absorption of moisture as to force them open), the kernels will germinate the same as when the pits are cracked by freezing.

With the pits or kernels planted, by whatever method, they should germinate readily in the spring with the return of good growing conditions. Under favorable circumstances the seedlings will grow rapidly, and before the end of July a large proportion should be $\frac{1}{4}$ inch in diameter at the surface of the ground and large enough to begin budding. This operation may be continued through July, August, and into September, provided growing conditions are favorable. In case of severe drought in midsummer, the bark may "set" at almost any time during the months named for budding, and thus bring to an end the budding period for the season unless growth is renewed later by the return of favorable conditions.

PLATE VI. — A peach orchard in a broad portion of the Gunnison Valley in Colorado. The elevation is about 5000 feet.

BUDDING

Selecting the buds.

As previously stated, the peach is propagated almost exclusively by budding, the shield or "T" bud method being used. The buds for this purpose are taken from the growth of the current season. They should be well matured, hence those near the terminal end of the limbs may need to be discarded, especially at the beginning of the budding season. Furthermore, the buds should be selected with great care both as to health and vigor of bud and identity of variety. Special regard should be taken for "peach yellows." If buds are taken from a branch that actually shows this disease developing, it is probable that little if any harm will result subsequently to the orchard since few of the buds are likely to grow, or if they do start, they will not live long enough to reach the orchard. But if buds are taken from the apparently healthy part of a tree in the early stages of this disease, the buds may be expected not only to develop into trees, but in course to develop the disease themselves before they have produced much fruit. It is, therefore, of the very greatest importance that buds be selected from trees that are entirely free from disease in every respect. The significance of this admonition is now generally appreciated, though this was not the case formerly.

And again, a wide difference in the bearing habits of peach trees growing under identically the same conditions is frequently observed. Some trees habitually bear heavy crops of especially high grade fruit of the variety; others may bear an undesirable grade; while others may be habitually barren or nearly so. Investigations of such differences

in the behavior of fruit-trees point strongly to the conclusion that, in part at least, these differences are inherent tree qualities and to the extent that this is true they are doubtless transmitted to trees propagated from them. While the truth of this with regard to peaches has not been demonstrated it appears to have been proved beyond reasonable doubt with regard to citrus fruits.[1]

This matter has too great potential possibilities to warrant its being ignored when propagating deciduous fruits. To take advantage of it, buds for use in propagating peaches should be selected from trees that bear the best crops of the most desirable fruit of the variety and which produce them with the greatest regularity.

Details of budding.

The details of budding are shown in Figs. 1 and 2. A single bud is inserted on the seedling stock at a point just above the surface of the ground, and for convenience in cultural operations, the point of insertion is on the same side of all the stocks. If necessary, the small branches that have developed near the ground are stripped off before the actual operations of budding begin.

As may be seen at "*A*" in Fig. 1, a vertical slit about 1 inch long is made through the bark of the stock and at its upper end a short horizontal cut is also made. "*B*" in Fig. 1 shows the next stage, which is merely *A* with the bark along the lines of the "T" slightly raised ready to receive the bud. Figure 2 shows a "bud stick." It is the end

[1] Shamel, A. D., "Citrus-Fruit Improvement." Farmers' Bull. 794. U. S. Dept. of Agr. Bull. 623, "Citrus Fruit Improvement: A Study of Bud Variation in the Washington Navel Orange," and Bull. 624, having a similar title but relating to the Valencia orange.

of a limb which grew the current season and from which the leaves have been cut with a small portion of the stem — about $\frac{1}{4}$ inch — being left on each one to serve as a handle when the bud is removed from the "stick." As shown in the figure, removal of a bud is effected by cutting upward, beginning at a point $\frac{1}{2}$ inch or so below the bud and extending about the same distance above, and deep enough so that a

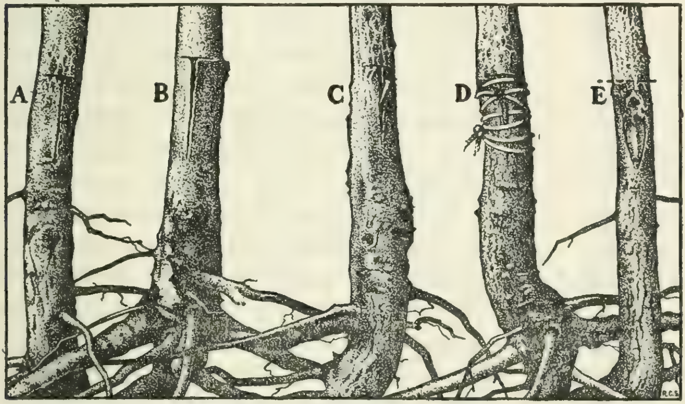

Fig. 1. — Details of budding.

very thin shield of wood just beneath the bud is removed with it. This small piece of wood is sometimes, though not usually, removed before the bud is inserted as shown in "*C*," Fig. 1. Ordinarily each bud is cut from the stick as the budder is ready to slip it into the "matrix," as the cut is sometimes called. Or the buds may be partially cut before, and the removal completed at the time of insertion.

The bud, with its shield of bark, is slipped entirely into the matrix. The next and final step is tying. This is shown in "*D*," Fig. 1. A piece of cotton twine (about No. 18)

is used for this purpose. The twine is cut into pieces about 10 inches long and carried in small bundles of convenient size attached to the person of the budder. Tying consists in winding the string closely, but not tight enough actually to girdle, about the part of the stock containing the bud, passing it around usually three or four times both above and below the bud. This binds the parts together firmly and holds the bud in perfect contact with the tissue of the stock immediately beneath the bud. Without this close contact the bud and stock would not unite.

Fig. 2. — A "bud-stick" showing manner of removing buds.

Tying is done from the lower part of the bud upward. It is accomplished by passing the second turn over the free end of the string, and continuing until the parts of the wound are all brought closely into position. The finish is similar to the beginning in that the end is passed under the last turn of the string about the stock and drawn down tightly. Thus both ends of the string are made fast without the necessity of tying any knots.

In commercial operations, the budder cuts the matrix and handles the buds, putting them in position in the stocks; a helper, commonly a boy, does the tying. If it is necessary to remove the lower leaves or small limbs on the stocks in order to expedite the budding, it should not be done more than a day or two in advance, since it

might cause the bark to "set" under some conditions if done too long before the budding.

It is very important that the buds be kept in a perfectly fresh condition after the sticks are taken from the trees. The supply which the budder carries with him is usually kept in a moistened piece of burlap slung across the back or in a bag of some kind where the sticks can be reached conveniently, but only one is carried in the hand at a time, unless the varying size of the stocks makes it desirable to have in hand buds bearing shields of bark of sizes to correspond with the stocks. Then a budder may carry in his hand at the same time several bud sticks of different sizes.

The skill of budders varies greatly, as is often evident from the varying percentages of failure which appear in rows of stocks budded by different men; their deftness also varies greatly. A rapid budder with a helper to tie will put in 2500 to 3000 buds in a day, occasionally considerably more, but such budders are quite exceptional.

In ten to fourteen days after the budding is done, the bud will have "taken," that is it will have united with the stock if it is to grow, or it will have become dry if it fails to "take." At the end of this period (ten to fourteen days after budding), the string is cut by passing a sharp knife over it on the side opposite the bud. This is to prevent girdling the stock and strangling the bud; but the bud should remain dormant until the next spring, at least when the budding is done during the period mentioned above.

In some sections, particularly in the South where the growing season is very long, "June" or "summer" budding is practiced to some extent. The stocks in those regions where the season of growth begins early attain a sufficient size to bud as early as June. Well-matured buds of the

current season's growth or buds from the previous season that have been kept dormant by holding in cold storage are used when "June budding" is used. The details of the operation are the same as when done later, but thus early in the season the buds should start into growth at once instead of remaining dormant until the following spring. In the far South, June or summer budding can be done until about July 10, but later than this the buds will remain dormant till the next spring.

By autumn such early budded trees should be large enough to plant, though naturally not as large as those which have an entire season in which to grow. Thus, in June budding a year is gained in the nursery and some growers find such trees eminently satisfactory. They should be somewhat cheaper in price, of course, than the older trees.

The removal of the top of the seedling stock, the part above the bud that has been inserted, is a detail requiring care. In the case of trees budded at the usual time, the seedling top is cut off the following spring about as the bud which is to give rise to the new top starts into growth — or just after it starts. The cut should be made just above the bud, leaving only so much of the wood above the bud itself as may be necessary to prevent drying out. If too long a stub is left, it will not heal over well. The point of removal is shown in "*E*," Fig. 1.

In the case of June budding, the seedling tops are removed at the time the string with which the buds are tied is cut, but any leaves or small branches that may develop from points below the bud are allowed to remain until the bud has made a growth of 3 or 4 inches, and then they are removed. Plate VII shows a block of June buds in a Florida nursery as they appeared about the middle of September.

The budding was done about the middle of the preceding June.

Some nurserymen in removing the seedling stock above the bud, make two cuttings — the first some 3 or 4 inches above the bud at the time growth is starting in the spring; and the second, after the bud has grown a few inches. The second cut removes the stub close to the bud. Less danger of the bud drying out is claimed for this method. The same thing is accomplished by cutting the stock partially off and lopping it over for a time and later removing it entirely.

In nursery practice it frequently happens that the stocks prior to budding do not grow uniformly in size so that it becomes necessary to bud over a block a second time in order to "work" the stocks that were not large enough at first. The stocks on which the buds have failed to take are rebudded at the time the strings are cut.

Growing the trees from the bud.

The growing of the trees in the nursery is primarily a matter of good culture. A fairly rapid growth is essential to the production of high-grade trees. As in the case of almost any crop where similar ends are in view, the soil must be maintained in a fertile condition, and very frequent tillage, especially during the early part of the season, is necessary. If the growth which the trees are making justifies it, tillage operations can be reduced somewhat toward the close of the season. The trees must be so managed in this respect that they will ripen well for fall digging.

However, certain other details are necessary in order to produce high-grade trees. As the bud on each stock starts into growth, there develops from it a single shoot which in turn becomes the leader or central axis of the tree. By the

time this shoot has reached a height of 12 to 15 inches, small side branches will begin to develop. From time to time, until the height at which the head is to be formed is reached, these side branches are removed, in order to produce a straight, smooth trunk. These branches are tender and are usually pulled or snapped off, since the wounds made by removing them in this manner heal better and more smoothly than when they are removed with a knife. Moreover, in rapid work with a knife it would be difficult not to leave many short stubs that would not heal well.

At the end of one season's growth in the nursery, the trees are ready for planting permanently in the orchard. Those that were budded early in the summer and the buds started into growth at once are usually referred to as "June buds." Those that were budded later and the buds remained dormant until the following spring are designated at the end of the one season's growth in the nursery as "one-year-olds." These trees make up the great bulk of the peach stock delivered by nurserymen for both fall and spring planting, though in some sections "June buds" are considerably in favor.

Dormant budding.

A method of dormant budding developed by Ness of the Texas Experiment Station and described by Price [1] is substantially as follows: At the point on the stock where the bud is to be placed, a slip is cut extending downward for about an inch and deep enough so that a thin shaving of wood remains on the "tongue" or flap of bark thus made. The tongue remains attached at

[1] Price, R. H., "The Peach," Bull. 39, Tex. Exp. Sta. (July, 1896), p. 839.

the lower end of the cut, but the upper half or two-thirds is removed. The bud to be inserted is cut in about the same manner as for shield-budding above described. In putting the bud in position on the stock, its lower end is placed under the portion of the tongue that remains and then the bud is bound to the stock by closely wrapping it with raffia or cotton twine in much the same way that the buds are wrapped in shield-budding. In placing the bud, however, much care must be exercised to bring the cambium layers of the bud and stock into as complete contact as is possible. If they are not in contact, no union of bud and stock can occur. In due course the raffia or cord used in wrapping the bud should be removed.

Though this method was apparently devised by Ness working independently, it was found later to have been used in Europe in its essential details at an earlier date. In principle, it is a modification of patch-budding, though that method is used generally when the bark "slips" readily. The special advantage of this dormant method is that it admits of budding when for any reason the bark of the stock is not slipping. Price speaks of budding peaches by this method in January, in which case not only the stocks but the buds must have been dormant.

CHAPTER V

DETAILS OF PLANTING AN ORCHARD

The essentials of a good location and a suitable site for a peach orchard have been considered and the propagation of peach trees has been discussed in some detail. In preceding chapters the relation of each of these factors to successful peach production has been presented. In establishing a peach enterprise, the planting of the orchard is logically the next step. This part in the development of a project is fundamentally a series of details. The grower may exercise a wide range of personal choice and preference in working them out, but within that range there are numerous requirements which must be fully and intelligently regarded; otherwise, costly mistakes which cannot be corrected later, and which will reflect adversely throughout the life of the orchard, are bound to occur.

TREES FOR PLANTING

Varieties.

In the important matter of securing trees for planting an orchard, the choosing of varieties obviously calls for critical consideration. Several fundamental factors enter into the making of a wise selection. They include: (1) adaptability to the conditions; (2) suitability for the markets where the fruit is to be sold or to the purpose for which

it is to be used; (3) sequence of ripening of different varieties either in the same orchard or in relation to fruit from other regions with which it may come in competition in the markets. Selection with reference to the latter point is of much greater import than is sometimes realized.

Amplifying these several factors, it is obvious that a variety to be profitable must be sufficiently well adapted to the conditions where it is to be grown to reach a good degree of perfection in development, otherwise the fruit must fail in the markets where it comes in competition with that which is better. In many sections hardiness of fruit-buds is a dominating consideration and in such sections varieties should be selected with that in view.

If distant markets are to be served, it is of primary importance that a variety possess good shipping and carrying qualities. Some of the leading commercial varieties have gained their prominence mostly on account of these qualities, though their attractive appearance has been a factor.

Moreover, a variety to be of value commercially must be highly productive, but for home use productiveness is of minor importance, since the standard of its value is not a money one. If need be, quantity can be sacrificed for high dessert quality. There is also choice in varieties for dessert purposes and for canning, drying, and other uses.

When a grower is heavily engaged in the peach business and desires to ship throughout the longest possible period, it is important that his varieties ripen uniformly in continuous sequence. Otherwise he cannot use his crew economically and to the best advantage. Unless his varieties are well chosen, he may have several sorts ripening together and consequently with a large quantity of fruit on some days

and none at all on others. Or if he has only a few varieties, it is important that they ripen at a period when the markets are not overstocked with fruit from other sections with which he cannot successfully compete. For instance, the Greensboro peach in some parts of New Jersey ripens with the Elberta in some of the peach sections of Georgia. They commonly reach the same markets with the competition in favor of the Elbertas. But some of the New Jersey growers may feel that they can risk something on the Greensboro in the chance of the Georgia crop being injured by adverse climatic conditions. In the same manner the Salwey peach was formerly an important variety in certain sections in California, but it ripens with the Elberta in the Grand Valley in Colorado. As the two varieties commonly reach the same markets with the competition in favor of the Colorado-grown Elbertas, the Salwey now rarely occurs in the younger orchards in these California sections.

The behavior of a variety in any location, that is, its adaptability to the conditions where grown, is likewise a very definite element in the problem of varieties. Varieties respond differently to different conditions. Those poorly adapted to the conditions where grown or to the purpose for which they are desired may, therefore, if planted, foreshadow the failure of an orchard. The experience of other growers in the locality, or in regions where conditions are similar to those that may be in question at any time, is the best guide in this respect.

Tree grades and sizes.

It is a common opinion that nursery trees are good in proportion as they are big, but for ordinary purposes this is a mistaken idea. The opposite extreme is equally to be

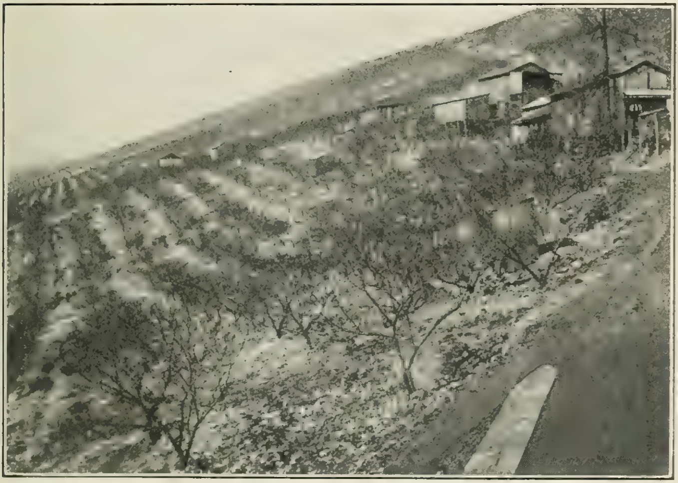

Plate VII. — *Top*, a block of "June budded" peach trees in a Florida nursery; *bottom*, an orchard site on the slope of a ridge in the Alleghany Mountains. Elevation about 1500 to 2100 feet.

avoided. As a rule, medium-sized, thrifty, well-grown, well-rooted one-year-old trees that are free from insect pests and fungous diseases should be selected. It was stated, however, in the chapter on propagation that "June buds" were popular with some growers (page 62). This grade of tree is not extensively planted, but it has proved very satisfactory in some sections, more especially in the middle latitudes and the South. The trees are light to handle; as the nurseryman gains a year's time in the use of the land, he can sell them for less than yearling trees; and under favorable conditions but very small loss occurs in transplanting, and they are but little if any behind one-year-old trees in bearing when planted at the same time. As a rule June buds make a late growth in the nursery; therefore, they should not be dug as early as one-year-old trees sometimes are handled.

In California "dormant buds" are sometimes planted. They consist of the dormant buds that were "worked" on seedling stocks the previous August or September and which, if allowed to grow in the nursery another season, would make the ordinary one-year tree. While these are not much used, they are said to give good results under favorable conditions, especially in California.

Further reference to one-year trees which make up the great bulk of those that are planted is needed. The different grades are commonly designated by the height of the trees, as 3 to 4 feet, 4 to 5 feet, 5 to 6 feet. The size of the trunk, or caliper, is sometimes considered and designated as follows: $\frac{5}{8}$, 4 to 5 feet; $\frac{3}{4}$ up, 5 to 7 feet. Here the fractions denote in parts of an inch the diameter of the trunk just above the point of union of stock and bud, and the whole numbers indicate the height of the trees. In the

last form, "$\frac{3}{4}$ up" means a tree having a diameter of trunk of $\frac{3}{4}$ inch or more. Still another method is when the height of the different grades overlaps, as 4 to 5 feet, $4\frac{1}{2}$ to 6 feet, 5 to 7 feet, these terms being equivalent to small, medium,

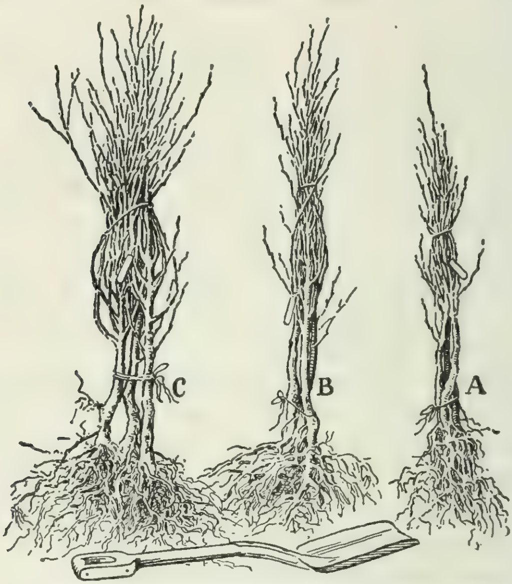

FIG. 3. — Different grades of nursery stock: A, 3 to 4 foot, B, 4 to 5 foot, C, 5 to 7 foot grades.

large. These grade designations are based on caliper as well as height, though the caliper is not stated. Thus, a tree 6 feet high, if it has sufficient caliper, goes in the 5 to 7 foot grade; otherwise, it may be put in the $4\frac{1}{2}$ to 6 foot or medium grade.

The relative size and height of trees of different grades are made apparent in Fig. 3. The heaviest grade (C)

is composed of larger, more heavily branched trees than the smaller ones; but they are more bulky and heavier to handle, and it is a question whether they will develop into any better trees ultimately than the medium-sized grade. A larger percentage of loss in transplanting is likely than when the next smaller grade is used. The smallest grade (A) is composed of fairly good trees, but some of them may be lacking in vitality or have poor root systems. Sometimes, for the sake of reducing the first cost, a grower buys even smaller trees than the 3 to 4 foot grade, but in most cases this proves to be false economy. A few cents a tree of additional cost means comparatively little in the initial expense of starting an orchard, but it may mean a vast sum later in the life of the orchard in the better development of good, vigorous trees.

While it is of importance that the tops be symmetrical and free from ungainly branching, which cannot be corrected in shaping the trees when planted, the condition of the roots is of even greater concern. They must be abundant; there should be many fibrous roots, but everything in the nature of "crown-gall" should be avoided. This is a corky or wart-like excrescence, sometimes of considerable size, that forms on the larger roots or on the crown of the tree just at the surface of the ground. While there is a wide difference of opinion and experience concerning the seriousness of this trouble, it is by far the safer plan to discard trees so affected; the roots in any event are abnormal, and if planted there is always the possibility that the trouble will develop to such an extent as to affect seriously the vigor and durability of the tree. All trees showing crown-gall or abnormal growths of any kind should be rejected. The risk is too great to justify one in doing otherwise.

Before planting an orchard, every prospective peach-grower who has important interests at stake should form an accurate conception of what constitutes good nursery trees in every respect. He should thoroughly familiarize himself with the appearance of the insects and diseases that are recognized as likely to be disseminated on nursery stock, and he should give particular attention to the character of the roots and their freedom from diseases and insects. Powdery mildew, bud mite, peach stop-back, and black peach aphis are the more common parasitic troubles in the nursery. These are discussed in the chapter on insect and disease control.

Where to obtain trees.

It is often a problem with prospective peach-planters whether to secure their trees from the North, from the South, or whether their having been grown in some particular section of the country is of material advantage in the future value of the orchard. A good well-grown tree typical of the variety, and which is free from insects, diseases, and other defects, is such regardless of the place or section where grown. The growing of trees having these qualities depends on favorable conditions and proper management in the nursery. These factors are not peculiar to any particular section or sections.

The inherent qualities of a variety do not change when the trees are grown in different regions. If the variety is hardy, it will continue to be so; if it is susceptible to some disease, it is not made less so by growing the tree during its nursery period in some particular place or region.

Economy in transportation expenses suggests the wisdom of purchasing trees as near the place where they are to

be planted as is practicable. Moreover, trees shipped long distances sometimes suffer injury if they are not properly packed or if they pass through severe extremes of temperature while in transit. And, other things being equal, the nearer the nursery is to the site where the trees are to be planted the shorter the period of time during which they are out of the ground. While this is not a matter of serious import, it is sometimes well worth consideration. On the other hand, differences in the price of trees of the same grade offered by various nurserymen, the desire to secure trees of some special varieties, or some other reason may make it preferable to ignore the relative proximity of nursery and orchard site and to be governed by other factors in placing the order for trees.

Furthermore, it is always a good plan to deal direct with the nurseryman rather than with the traveling tree peddler. It is never certain where or how the jobber obtains his stock. It is, therefore, better business to deal with a permanently established nursery, the success of which is dependent on the character of service it renders its patrons. The jobber or the peddler as a rule has no fixed place of business beyond the season's activities. He can move to new territory without loss of assets.

TIME OF PLANTING

There is a wide range in the time when peach trees may be planted in different parts of the country, the range depending mostly on climatic conditions. No arbitrary directions as to the time can be given. In general, it may be stated that in the northern latitudes, or wherever the winters are severe, either from low temperatures, the prevalence of much drying wind, or the habitual occurrence of other

atmospheric conditions that induce high evaporation, planting in the spring as early as the soil can be put in suitable condition and after the danger of hard freezes is past is to be advised. But in the middle and southern latitudes and in regions generally where the winters are mild and where the fall season is favorable for working the soil until late, the planting of trees at that season of the year is generally successful and by many is preferred to spring planting.

The planting should be delayed until thoroughly well and naturally ripened trees can be obtained, but before the advent of really cold weather. In some of the milder parts of the country, where the soil seldom freezes deep and rarely remains frozen for more than a few days at a time, peach trees are commonly planted at almost any time during the winter, excepting possibly for a few weeks during the coldest weather, when conditions are unfavorable for working the soil.

Kyle[1] states that in Texas peach trees may be planted from the first of November until the middle of March, with a preference for the month of December because of the soil and climatic conditions that usually obtain then.

Some peach-growing regions are virtually on the "border line" between fall and spring planting. Whitten, who has perhaps given this matter more experimental attention than other investigators in this country, finds that in central Missouri peach trees planted in the fall have made a better growth the next season when the planting has been followed by a favorable winter, but if followed by a severe winter, the trees have dried out and winter-killed to some extent. In southern Missouri, on the other hand, fall planting has proven regularly to be preferable.

[1] Tex. Exp. Sta. Bull. 80, p. 10.

In Whitten's work, late fall planting, that is, during early December, has been much more satisfactory than earlier, October 15 to November 15. This appears to be because the roots, contrary to common belief, begin no action until after the surface of the ground starts to freeze; and when the trees are planted a month or six weeks before it gets cold enough to freeze the soil, the trees dry out and lose vitality. The late fall-planted trees start root action as soon as those planted early, and they escape the period of several weeks of desiccation suffered by the latter. It appears even that trees transplanted late may endure a severe winter better than when left in the nursery. It has been suggested that the slight desiccation of the top which doubtless occurs, even when planted late, may give, indirectly, a greater cold resistance to the tree.

In the milder sections, where the ground does not freeze to the depth occupied by the roots, more or less root development occurs all winter on newly planted trees. Thus, when growing conditions return in the spring, the trees are in good condition for immediate starting into growth with the roots fully supporting it.

In case of spring-planted trees, the leaf-buds sometimes begin to push before there is enough root action to support the growth, thus resulting in a slow development of new wood growth for a time. Yet in the colder sections of the country, spring planting only is possible as the trees if planted in the fall would winter-kill.

Blake [1] advises that fall-planted trees be cut back quite heavily but not within three inches or more of the points to which they will need ultimately to be cut back the following spring. In the latitude of New Jersey both fall and

[1] N. J. Exp. Sta. Bull. 219, p. 13.

spring planting are practiced, but fall planting can be depended on only in well-protected locations and in the milder part of the state. Fall-planted trees sometimes suffer when on exposed sites by being whipped about by the winds. The motion of the trees in the wind loosens the soil from about the trunk, thus allowing water to collect in some quantity, which if it freezes may cause injury to the tree.

On the Pacific coast, where the annual climatic cycles divide the year into alternating "rainy" and "dry" seasons, the planting needs to be done with some reference thereto. The condition of the soil and the complete dormancy of the trees are the primary factors to be considered. Because of the tendency for trees to grow very late in the season in California nurseries, fall planting is not desirable. In many parts of California, after the first rains have moistened the soil well, usually early in January, the planting may be done to advantage, though some soils may be too cold and uncongenial at that time to make it advisable. Planting is usually deferred in such cases until early spring, though there is then some danger of the trees starting into growth before the soil reaches a suitable condition to be properly handled, especially since the period is short in that state when peach trees are thoroughly dormant.

It will thus be seen that the time of planting is a matter that calls for discretion. It is another illustration of the intimate relationship between climatic conditions and plant life. The principles, however, on which the decision should be based are fairly well defined.

HANDLING THE TREES WHEN RECEIVED FROM THE NURSERY

When received from the nursery, the trees are usually packed in boxes if the order is large, or in bales or bundles

if only a few trees are to be planted. Whatever the manner of packing, the trees should be unpacked at once on delivery at destination and so handled that there will be the least possible drying out of the roots. If the order consists of only a few trees and they are to be planted immediately, a little moist soil, wet straw, or even moistened burlap or gunny sack can be thrown over the roots and adequate protection thus provided. But if there is any considerable number of trees, or if there is to be any delay in setting them out, they can be protected best by heeling them in. The manner in which this is done

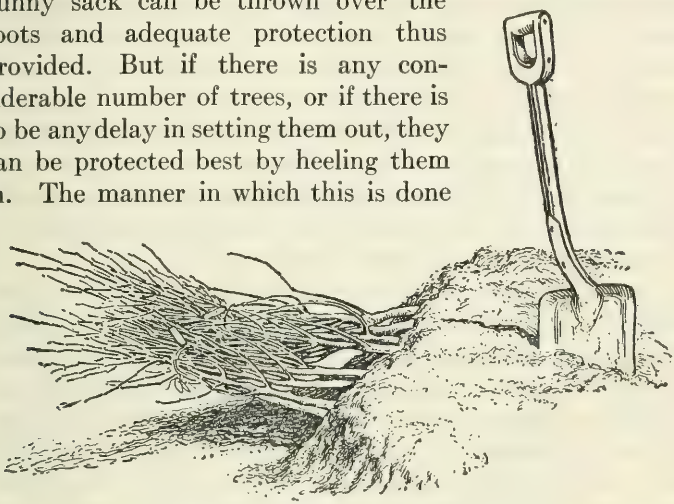

Fig. 4. — Peach trees heeled in.

is suggested in Fig. 4. A thoroughly well-drained place is required where the soil is deep and preferably a sandy loam, though any type that can be easily worked and finely pulverized will do. If the site is protected from prevailing winds or is a shaded area, it is all the better for the purpose.

A trench is opened, commonly, with a plow, the latter being run, if need be, several times in the same furrow.

The furrow or trench should be wide and deep enough to receive the roots readily. The roots of the trees are placed in the trench with the trunks extending at right angles to it and across the sloping or "land" side of the trench. If the trees are tied in bundles, as is often the case, they should be separated, at least the lower portions of the bundles should be released, so that the roots can be parted sufficiently to permit working finely pulverized soil very thoroughly in among them. Otherwise, air spaces will exist and the roots are likely to dry out to a serious extent.

If a large number of trees are to be heeled in at the same place, it will usually be convenient to place them in closely adjacent rows. When this is done, the trees in one row, for convenience, may be covered with the soil which is removed in opening the next adjacent trench.

Sometimes it is necessary to leave trees heeled in over winter. It is then well to place them in a nearly horizontal position, so that the entire portion of the trunks and even some of the larger branches can be readily covered with soil for the purpose of protection. Such protection is of particular importance in the colder peach-growing districts. The soil should be made rather firm about the trunks and roots, so that harbors for mice will be reduced to a minimum, as well as to give the best possible protection to the roots. In completing the heeling in, soil to a depth of several inches should be heaped over the roots.

Perhaps the one exception to the rule for the immediate unpacking of trees on arrival at their destination is when the shipment has been made during a period of low temperatures and the trees have been frozen in transit. The better course to follow in such a case is to place the box or bale without unpacking in a cellar where there is no direct sun-

light, and the temperature is but very slightly above freezing. Under such surroundings the trees will thaw very gradually in a uniform temperature and with less danger of serious injury as a result of the freezing than if handled in any other way that can be suggested. Under some conditions, as where no cellar having a suitable temperature is available, the trees may be buried for a time before they are unpacked. In either case they ought to be unpacked and properly handled as soon as they have thawed.

If trees are received in a badly dried out condition so that the bark is somewhat shrunken and shriveled, they can be saved sometimes by burying them at once in moist soil and allowing them to remain some days, or until the bark has regained its normal condition and appearance. Submerging them in water, especially running water, for a brief period is sometimes recommended for a similar purpose. However, every precaution should be taken to guard against adverse temperatures or the drying of the trees in transit. The methods of treatment suggested for such cases are only "last resort methods." which may prevent entire loss of trees so injured.

PREPARING THE LAND FOR THE TREES

The ideal preparation of the soil where peach trees are to be planted consists of deep plowing and thorough pulverizing with the harrow or cultivator. The preparation should be hardly less thorough than for planting corn, potatoes, or root-crops. It is also of the highest importance that the soil be rich in humus. For this reason it is likely to be an advantage if the site to be planted has recently been occupied by clover, cowpeas, or some other green-manure

crop which has been turned under. For a similar reason, in part at least, newly cleared land, which in some sections is used for peach orchards, gives excellent results. It has not been depleted of its supply of humus.

Because the trees occupy but a very small portion of the ground space, when first planted, there is always a temptation to set the trees with a minimum of preparation of the soil, but it is doubtful economy to slight this operation. On the other hand, some degrees of compromise may be resorted to in this matter of the preparation of the soil and still not defeat the end in view. For example, the removal of stumps from newly cleared land is generally costly, except as it can be done with the regular force employed in the orchard and at times when other routine operations do not require attention. Where such land is to be devoted to peaches, it is practicable to remove the stumps from a narrow strip along the line of each row of trees. This course admits of a good preparation of the soil in the strips before the trees are planted and thorough tillage throughout the following season. Each season thereafter, the strip freed from stumps should be widened with a view to extending the cultivation accordingly. By the time the trees come into bearing, the stumps should be fairly well cleared from the entire area.

A thorough preparation of the soil before planting will tend not only to make conditions favorable subsequently for a good growth of tree, but the operation of planting will be materially aided thereby. The holes can be dug better, and the refilling, after the trees have been put in position, can be done to better advantage when the soil has been thoroughly and deeply pulverized than when less attention has been given to its preparation. For a similar reason

it is obvious that newly broken sod land cannot be as readily fitted for the planting of trees as land that has been plowed a sufficient length of time for the sod to become well rotted.

LAYING OFF THE LAND

The trees should always be planted in straight rows or in some other definite and systematic order. This not only makes a nicer looking orchard, and is worth while for this reason alone, but any considerable irregularity in the placing of the trees will cause inconvenience and annoyance in caring for them.

Laying off the land consists in determining on and marking the exact spot where each tree should stand. There are various systems of arranging the trees in the orchard: the "square" in which the trees are so placed that any four opposing trees in adjacent rows indicate the corners of a square; the "alternate," where the distances between the rows and the trees in the row are the same, but the trees alternate instead of checking in squares, each tree in the row standing opposite the center of the space between two trees in adjacent rows; the "triangular," or "hexagonal" system, as it is sometimes called, where the trees are arranged as in the alternate system but each tree is equidistant from every other tree. In this system the rows are not quite as far apart as are the trees in the row, and thus the sides of a triangle indicated by a tree and the two nearest it in an adjacent row are equal. The term "hexagonal system" is applied because a line joining any six trees surrounding a seventh as a center forms a hexagon. By this system a somewhat larger number of trees can be planted on a given area of land than by any of the others and without placing

them any nearer together than the distance between the trees in the row.

Of these systems, however, the first one, planting in squares, is used so largely in setting peach orchards that the others require no consideration in detail here.

Distance between trees.

Obviously in laying off the land by any system, the first decision must be in regard to spacing the trees. Common distances are 18 by 18 feet, 18 by 20 feet, or 20 by 20 feet, requiring respectively 134, 121, and 108 trees to the acre. Closer planting is sometimes practiced, but it is rarely advisable, while under some conditions 24 by 24 feet probably does not allow the trees more space than they need. The latter distances are perhaps used in California more often than in other parts of the country. Authorities in that state advise never to plant closer than 24 feet apart each way unless on sandy soil. Moreover, the topography of the land, the fertility of the soil, the varietal characteristics of the trees, and the preferences and convictions of individual growers, are all factors to be considered.

When the site is a steep even slope, such as is shown in Plates III and VII, the trees may stand a little closer together in the rows running up and down the slope than in those parallel with the slope, since in the former direction each tree is somewhat elevated above its neighbor below and not as much shaded as if standing on the same level.

The reason for allowing liberal distances between trees is suggested in Plate IX. This shows a peach tree when about five years old. Its branches spread 18 feet; its roots extended at least 36 feet. They were traced 19 feet on one side and 17 on the opposite side. The branches of trees

PLATE VIII. — Orchard sites at different levels in the valley of the North Fork of the Gunnison River in Colorado. Elevation 5600 to 5700 feet.

this size would have nearly interlocked between the rows if planted 20 by 20 feet. And more than this, the roots of adjacent trees would have overlapped and competed for moisture and plant-food, long before the branches of opposing trees would have interfered with one another. In other words, the roots of opposite trees are likely to crowd much earlier in the life of an orchard than are the branches of the same trees, when planted at the usual distances.

The distances between the trees decided on, any one of several methods of determining the proper spot at which to plant each tree may be used. Doubtless the simplest and most accurate way is by the use of a surveyor's compass and chain. A crew of four men can do the work expeditiously and well, one to sight the compass and align the placing of a stake for each tree, two to handle the chain and another to carry and drive the stakes at the proper points as designated by the head chainman and in correct alignment as indicated by the man at the compass.

In the absence of a compass, if the land is fairly level, a simple home-made device can be used. This consists merely of two narrow strips of board 18 to 24 inches long which are placed crosswise to each other at the center and secured. A small nail is then driven through each of the four ends of the cross thus made, care being taken so to place the last nail that in sighting over the nail points lengthwise the lines of vision will be at right angles to each other. This cross is then attached in a horizontal position, nail points uppermost, to the end of a small stake of such length that when stuck in the ground firmly enough to retain its position the cross or "head" will be at a height convenient to sight over. This device is used in the same way that a compass is used, the nail points serving as the crosshairs

in the compass, and the two arms of the "head" taking the place of the 90° turn of the compass. While the distance which can be sighted with this arrangement may be limited, it can be moved from place to place, and readjusted quickly.

However, the more common way of laying out a field on the square system is as follows: A base line is run on one side of the field. This may well be the line of the first row of trees on that side. A stake several feet in length is driven into the ground at each end of the line. About midway between them a third stake is placed in line by sighting over the two end stakes. If the row is very long or the land uneven, it may be advisable to place several stakes at intervals between the two end ones. Then in line with this row of stakes the distances between the trees are measured off and a small stake driven down to mark the spot where each tree is to stand. Four men working together can do this part of the work advantageously. Two members of this crew carry the measuring rod, chain, or tape on which is marked the distance between trees; a third aligns the chainmen by sighting over the tall stakes previously set, while the fourth carries the supply of small stakes and drives them into the ground at the proper places as indicated by the head chainman.

Then, in turn, border rows are staked out in the same manner, running at right angles to the base row first located, and finally a fourth row parallel to the first one and on the opposite side of the field is staked out. If the field is irregular in shape, a square or rectangular block is staked out in the manner described and the irregular corners and sections filled in later.

If the field is very large, it may be best to stake in several cross rows, with the tall stakes as described in locating the

base line in the beginning. By following this course, there are provided at least two stakes (and more if the cross rows have been filled out) over which one may sight in aligning the trees when they are being planted. The spot where each tree in each row is to be placed may be marked in the same way as described for the basal row.

A less accurate way of laying off land for an orchard, but not infrequently used, is to strike small furrows with a light plow along the line of the rows, the plowman being guided as accurately as possible by conspicuous stakes placed at intervals along the course of the rows as previously described, and then checking in the opposite direction at the proper distances in a similar manner, or perhaps by a man dragging a heavy chain, the points of intersection of the furrows or other marking being the approximate spots where trees should be placed.

While there are various other ways in which an area may be laid out for planting to trees, and perhaps under some topographic conditions others would prove preferable, the methods described may be suggestive.

Where the topography is very steep and broken, especially if there is danger of the soil washing, it is advisable to run the rows with the contours rather than to plant in squares. When this is done it is impossible to follow any regularity in placing the trees. With the rows following the contours, it is obvious that the distance between them will vary according to the irregularities of the surface. While it is possible to place the trees at a specified distance apart in the rows, a compromise may be necessary in locating the rows between conformity with the contours and such a departure therefrom as can be made and yet afford protection against washing in the management of the orchard.

MAKING THE HOLES FOR THE TREES

Making the holes where the trees are to stand is a simple matter, if the land has been well prepared, but it is nevertheless an important one. They should be large enough to receive the roots without bending them from their normal position and deep enough so that when filled the trees will stand two or three inches deeper than they stood originally in the nursery row. This deeper planting has no adverse results unless the soil is very heavy, when about the same depth as in the nursery row may be advisable. Fairly deep planting insures, in a measure at least, against the roots becoming exposed through the washing of the soil from the trees or its being worked away in the subsequent tillage of the orchard. Trees that are planted too shallow do not thrive as a rule.

The inexperienced planter frequently raises a question about the advisability of making the holes considerably larger than the roots and filling in with rich soil. While there can be no objection to doing this, it adds materially to the expense of planting the trees, and there is probably little to be gained by it if the soil is in suitable condition and the subsoil is well adapted to the object in view.

The making of the holes is generally accomplished in one or the other of two ways. After the site has been laid out as described, men with shovels or spades, and picks if need be, dig holes, or deep furrows are opened by running a plow two or more times along the line of each row, thus throwing out the soil and leaving but little more to be done with a spade at the points where the trees are to be placed. By the former method, if the ground is in good condition for planting, a man should dig at least 100 holes in a ten-hour day. Not infrequently a considerably larger number is

dug. When the latter method is followed, it assumes that the rows and the trees in the rows will be located mostly by sighting over relatively tall stakes properly placed at the ends of the rows, checking in both directions.

On account of the holes or furrows drying out badly, it is probably better not to make them too far in advance of the planting.

The use of dynamite in preparing the holes where fruit-trees are to be planted has been much advocated in recent years. Some of those who have had dynamite to sell have been particularly enthusiastic in claiming advantages for it. This method, in brief, consists in exploding from a half stick to a stick of low grade dynamite, a 25 to 40 per cent grade, at the point where each hole is to be made, the hole for the explosive being made with a crowbar or some other similar implement, usually about 30 inches deep and large enough to admit readily a stick of dynamite of the usual size. The explosion is effected by use of a percussion cap and fuse as when employed for other purposes. The advantages commonly claimed for this method are that the subsoil is shattered, thus making it easy for the roots to penetrate it as they grow; it is pulverized, thus increasing the area in which the roots may forage; it increases the water-holding capacity of the soil; it assists in soil drainage and gives benefits in other ways, — all of these factors resulting in a smaller loss of trees through failure to grow; larger growth, earlier fruiting, and still other advantages. Also, it so loosens the soil as to render it possible to dig the holes for the trees with a spade alone, no pick or other implement for lightening the soil being necessary, and thus materially lessening the labor and expense of excavating where the trees are to stand.

These claims in part may or may not be realized. Much depends on the character of the soil and subsoil and their condition. The condition of the subsoil at the time the blasting is done is of particular importance. The great danger of this method is that the claims made for it will be accepted without the necessary qualifications that should accompany them, and dynamite used without due discrimination and in anticipation of its being effective in making any sort of an impossible soil condition fully suitable for peaches or other fruits. It may be questioned consistently whether a soil that is inherently unsuited for peaches can be adequately and permanently improved by its use, or whether one that is well suited for peaches will be materially benefited by it. Yet in some cases there has been some benefit in the growth of the trees during the first year or two which is unmistakably traceable to the effect of the dynamite used in preparing the holes. It is true also that the fitness or unfitness of soils for the growing of peaches is relative. All degrees towards either extreme may exist, at least in the abstract.

Perhaps the one condition that is unmistakably amenable to a beneficial effect of blasting with dynamite is where there is a stratum of hardpan a few inches below the surface and below which the subsoil is satisfactory and the conditions otherwise favorable. The hardpan stratum can usually be broken up with dynamite and the conditions thus materially and perhaps permanently improved. On the other hand, positive injury may and usually does follow if the subsoil is too moist when the explosive is used and especially when it contains considerable clay. Instead of shattering and pulverizing the soil the explosion creates a chamber, thereby greatly compacting the soil within the radius of its effect, thus making conditions worse than in the beginning.

The advice commonly is to do the blasting some months in advance of the planting so as to allow time for the soil to settle. This may correct some of the troubles otherwise encountered, but the question that inevitably presents itself is whether it is worth while in the long run to invite trouble in this way. Whether the use of dynamite is advantageous or otherwise is fundamentally a question of soil conditions, and where used it must be done with keen discrimination if disappointing results are to be avoided.

In the practical application of this method of preparing the holes, results vary greatly. There are those who are convinced by their experience in using it on a large scale that it is a highly desirable practice. Others have gained nothing from it. One extensive grower says, "We have used dynamite but do not as yet see sufficient difference in the trees to warrant the additional cost." Another grower, six years after using dynamite in part of a planting of 20,000 peach trees, affirms that: "The cost of dynamiting was three times that of digging, and no difference in growth of trees planted by the two methods developed. This experience coupled with observation elsewhere leads me to believe that on good peach soil no advantage will result from dynamiting the holes."

The results, in general, obtained by the New Jersey Experiment Station in a series of experiments under different soil conditions in several places in the state have been conflicting. In one case the blasting has been without appreciable effect; in another, the results have been profitable without question; while with many trees differences in growth in favor of dynamiting during the first two years after planting are equalized by the time the trees are five or six years old. In some cases the trees planted in dynamited holes

have at first developed larger and deeper root systems than those planted in the usual way, but this appears to be without important significance in soils that are suitable for peach-growing. The situation is summed up briefly in the statement that: "There are soil conditions where dynamiting is beneficial for tree planting. There are other conditions where no distinctly beneficial results would be obtained."

In view of the conflicting results which are based on wide experience in preparing the holes with dynamite, the question of whether to use it or not is still an open one and must be settled evidently on the basis of the conditions in each case. The problem has been stated and some of the factors that bear on it have been mentioned. The prospective planter must know his soil if he is to handle it to the best advantage possible.

PLANTING THE TREES

The grower has prepared his soil, laid out the site for planting, and has made the holes for planting the trees or is prepared to do so as the work of planting progresses.

The details that have to do with putting the trees in position in the places marked for them in laying out the site are numerous and require careful attention but in execution may be widely varied. The following presentation of details should be considered as suggestive only and to be varied in practice as the individual planter's condition and preferences dictate.

As stated in another place, one-year-old peach trees, that is, those that have made one season's growth from the bud in the nursery, are generally used in planting peach orchards.

In digging trees from the nursery a considerable part of the root system, especially many of the fine fibrous roots, is

habitually left in the ground, and the larger roots that remain attached to the tree are apt to be more or less broken and perhaps bruised to some extent. In preparing a tree for planting, all portions of the roots which have been mutilated in digging the trees or injured by any other means should be trimmed off, and long slender roots, if they occur, are usually cut off to correspond with the length of the general root system.

Unless the trees are of the larger grades, all the branches are commonly removed, leaving only a single, unbranched stem. This stem should be headed back to correspond with the height at which it is desired to form the head of the tree.

However, when the larger grades are planted, those which are 6 feet or more in height, and correspondingly large in caliper, it is usually safer not to trim to a single unbranched stem. There might, then, not remain enough buds which would give rise to branches properly placed to make a good symmetrical head. It is, therefore, wise to select from three to five branches as well distributed about the main stem as possible, from which to develop the head. The limbs thus selected for the foundation of the top should be headed back to short stubs, but on each there must be left at least one well-developed bud to insure a starting point for the growth

Fig. 5. — The top of a well-grown one-year peach tree as it came from the nursery.

of the branch. With small and medium-sized grades, there is little danger that an abundant growth of desirable character will not develop from the main stem; yet there is an increasing tendency with some growers to cut the branches back to stubs instead of trimming the tree to a single stem when using even some of the smaller sizes.

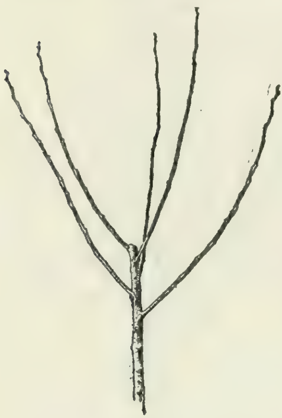

FIG. 6. — The tree shown in Fig. 5 after the branches which are to form the permanent top have been selected and the others cut away.

The pruning of large grade trees when planting them is illustrated in Figs. 5 to 8. Figure 5 shows the top of a tree as it came from the nursery. The same tree with certain branches selected as the foundation of the permanent top and the discarded part removed is to be seen in Fig. 6. The next step with the framework branches cut back to stubs appears in Fig. 7, while Fig. 8 is the same as the one preceding viewed from a point directly above it. The symmetrical arrangement of the limbs selected to form the permanent top is here seen.

In this case five branches have been reserved as the foundation of the new top. Some growers of wide experience affirm that three branches are sufficient and that a top formed of a larger number of main framework limbs requires more pruning, that it is more difficult and expensive to keep the top well opened to sunlight and air, and for which there are no adequate compensating features.

The top in Fig. 8 could have been reduced to three frame branches by removing completely stubs two and four, or such

other two as would result in a symmetrical spacing of the limbs. A space of several inches between the stubs, vertically up and down the stem, is desirable, since a stronger tree will result than when the framework branches all start from the trunk at about the same height.

FIG. 7. — The tree in Fig. 6 with the branches cut back to stubs.

In planting the larger grades of trees, the tops obviously must be formed at a height determined by the position of branches suitable for the framework, but the common extremes for heading peach trees as preferred by most growers range from 12 to 18 inches up to 24 or 30 inches. Some, however, have favored forming the heads within 6 inches of the ground, thinking thereby to bring the bearing surface correspondingly near the ground. But there are disadvantages in forming the heads too low, of which perhaps the most serious is in digging out borers.

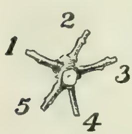

FIG. 8. — A view looking directly downward on the top of the tree in Fig. 7.

The effect of pruning peach trees at different heights when planted has been investigated by Blake.[1] His final summary of results affirms that "Peach trees at the time of planting should be pruned somewhat according to grade and the character of the stock, and not according to some definite height regardless of all other factors." He finds there is a fairly close correlation between the size of the trees and the number of buds that occur on the main stem at different heights and that a tree will start into growth better and will develop a better formed head the first season, if the main stem is well supplied with buds just below the point at which

[1] N. J. Exp. Sta. Bull. 293.

it is cut back. The obvious suggestion is that in planting peach trees the grower should treat each tree with some regard to its individual qualities and characteristics rather than by any arbitrary rule.

Sometimes after the roots are trimmed and before the trees are planted, there is danger of their becoming too dry, especially the smaller roots. This danger can be largely eliminated by puddling them. This consists in dipping the roots in a puddle of clay which should be of such consistency that a thin layer of mud will adhere to them. Such a coating of mud will afford considerable protection against undue drying out from unavoidable exposure to the sun and wind. Every possible precaution, however, should be taken to prevent exposure. Sometimes a large piece of burlap, kept well moistened, is convenient to throw over the roots of trees that are awaiting planting.

However, in large scale operations it is a good practice to haul the trees to the site where the planting is to be done with the roots packed in moist straw in the body of a wagon, and then to distribute them not much faster than they are planted.

The manner of staking out a site for making the holes has been discussed in a previous section. The tall guide stakes there described should remain in position until the trees are planted. The present course of procedure presupposes that the holes for the trees have already been dug.

In planting the trees, four men make a good crew. One goes ahead, distributes the trees and prunes them ready for planting. (The pruning of the tops can be deferred till later if need be.) Another man places the tree in the hole, aligns it in one direction by sighting over the guide stakes, or over trees already planted, after the work has made some progress. One of the other men aligns the tree in a similar manner by

Plate IX. — A peach tree root 19 feet long; one on the opposite side of the tree was 16 feet long. The roots of adjacent trees are likely to crowd before the tops do.

sighting in the opposite direction, then the latter and the fourth man fill the hole with finely pulverized soil, while the one who is handling the tree works the soil in among the roots very completely and packs it down firmly. When the hole is filled even full, the tree, as previously pointed out, usually should stand a few inches deeper than it stood in the nursery.

Special precautions should be taken in planting trees to insure the close packing of the soil about the roots. Nothing is so good as the fingers with which to work the soil in among them, though very slightly moving the tree up and down after a few shovelfuls of soil have been placed in the hole will help. Usually tamping the soil with the feet from time to time will effect such firming of it as is necessary.

A crew of four men working as above outlined should plant at least 500 trees in a day of ten hours. Under very favorable conditions, a particularly efficient crew may plant two or even three times that number. However, when these larger numbers are planted, the holes may not be filled completely at the time, since if enough soil is put in place to cover the roots well, the filling can be completed later and if need be by less experienced men. Finishing the work should not be too long delayed, especially if conditions are such that the soil is losing moisture rapidly. Otherwise the roots may become dry.

While the methods described above for preparing peach trees for planting and the details mentioned are those commonly followed, other practices are employed more or less. One of the widest departures from common practice is the "Stringfellow method" of root pruning in planting, so called from the name of its discoverer and chief advocate, the late H. M. Stringfellow of Texas. The distinguishing

feature of the method consists in pruning off all the roots, leaving only the merest stubs an inch, or even less in length. The top of the tree is also cut to a single stem 12 to 18 inches high. The most important claims for this system were ease of planting, vigor and strength of growth, longer life, a more downward course for the roots, and, because of the latter, the roots less subject to the varying influences of heat, cold, and drought.

In the early nineties, while this method was being somewhat strenuously exploited, a number of experiment stations as well as commercial peach-growers made some comprehensive tests of it, in some instances planting a series of trees with the roots pruned different lengths ranging from the usual practice to the opposite extreme of the Stringfellow method. In the main, the results were adverse for this method, only the first claim being realized. Since the roots were all pruned off to the nearest stubs, the holes were made with a crowbar, and obviously with very small cost. Many of the trees so planted failed to grow; others grew, but not as well as those planted in the usual way. As a rule, the method gave better results in the South than in the North. In some sections in the South it has been used successfully to some extent on a commercial scale. The results are summed up thus: "Reviewing all the data available, it would seem that in certain localities, particularly in warm, moist, loamy soils, the stub-root method of pruning back the trees may give entirely satisfactory results, but station evidence is generally in favor of less severe pruning. It has been clearly shown, however, that leaving on all the long roots of peach nursery stock is unnecessary and useless."[1]

[1] Smith, C. B., "Experiment Work with Peaches," in Ann. Rept. Office of Exp. Stations, year ending June 30, 1906, pp. 416–419.

While in the experimental work many of the trees with stub-pruned roots made good trees, one station in the South reporting that neither increase nor decrease of vigor could be detected as a result of the practice, the weight of evidence is in favor of leaving the roots at least 3 inches long and from that up to 6 or 8 inches, unless previous experience in a given locality and under known conditions has produced evidence that the close stub-pruning is satisfactory.

Another departure from the usual course is in the planting of "dormant buds." This method is sometimes used in California; rarely, if ever, elsewhere in this country. The details of handling dormant buds as described by P. W. Butler of Placer County, California, and quoted by Wickson[1] are as follows: "Have the ground prepared and stakes placed in position in the orchard in early February, if possible, and begin the planting at once, while the trees are dormant in the bud. Take no more trees from the nursery than can be planted in half a day. Plow a furrow on each side of the row, 6 inches from the trees, turning the soil from them, then two men with heavy spades or shovels, one on each side of the tree, can readily take it up without breaking many of the roots; and what are so broken should be smoothly trimmed with a sharp knife. Place the trees in a tub of water, near where they are to be planted, and take them from it only a few at a time. Put them in a basket or box and cover with wet sack, that they may be kept moist until placed in the ground.

"On planting, place the bud 1 inch below the level of the ground but do not cover it until after it has grown to the height of a few inches. The stock should be cut off at the bud with a thin, sharp knife (not with shears, as is often done,

[1] Wickson, E. J., "California Fruits." (Seventh ed., 1914), p. 239.

as the latter method will sometimes split the tree, when it will take in moisture, and not heal readily)."

Wickson, in the same connection, states that some growers do not cut off the stock until the bud has made some growth, the stock being girdled above the bud to force the growth of the latter. This gives the tender shoot as it puts forth from the bud protection to some extent. The growing shoot may even be tied to the stock for a time but the cutting off of the stock should not be delayed too long else the wound made thereby will not heal over entirely during the first season. While dormant buds handled in this way require considerable care, according to Wickson they sometimes outgrow one-year-old trees planted at the same time.

CHAPTER VI

ORCHARD MANAGEMENT

The usual operations that have to do with the maintenance of peach orchards include tillage, the interplanting of crops, fertilizing, pruning, insect and disease control, and in some regions irrigation. But little differentiated from these operations are such more or less specialized features of management as thinning the fruit, winter protection, heating or smudging to prevent injury from frosts during the blossoming period or from other untimely temperature conditions, and other operations as occasion may require.

While each of these major operations requires rather full discussion in separate chapters, their inter-relationships are so important and far reaching that brief reference to them from that standpoint should be made in the present connection.

To a very considerable extent regularity of bearing, productiveness, and longevity of the trees are a reflection of good management, especially with respect to tillage, fertility maintenance, pruning, and insect and disease control. The response made by the trees is nearly proportionate, at least within certain limits, to the care which they receive, the better the care and the wiser the management, the more regularly productive during the longest period of time and therefore the more profitable.

PERIOD OF PROFITABLE PRODUCTIVITY

Aside from the influence of good management on the period of productivity, there are apparently regional influences that are more or less potent. Under favorable conditions, an orchard may produce considerable fruit in almost any region in its third year, but on the other hand the fourth season after planting is as early as most growers expect a crop of commercial importance. If the trees fruit earlier, the grower is merely that much ahead. But in the duration of the trees there is a rather wide range. As above noted, good care counts for much, since depletion from the lack of tillage, neglect of pruning, impoverished soil, and the encroachment of insects and disease tend to shorten materially the productive life of peach trees. In general, even under good care, an orchard that has been planted twenty years is regarded as old. Few orchards in fact attain that age before many of the trees are badly broken to pieces or otherwise rendered of no account, and in some sections they are rarely regarded as profitable after they reach the age of twelve to fifteen years, the age being reckoned always from the time the trees are planted. The stimulation of new wood growth by tillage, fertilizing, and proper pruning, however, may add a considerable number of years to what would otherwise be the end of the profitable duration of an orchard.

Under the latter conditions and in some regions, an orchard occasionally reaches the age of twenty-five years in a fairly profitable state. An extreme case of this sort occurred some years ago in one of the older peach-growing regions of the country where an orchard which was then more than twenty-five years old was not only in fairly good condition, but it was the third peach orchard which had occupied the same

piece of land without the intervention of other crops of importance. Usually on account of the condition of the soil, it is not regarded as good practice to replant an orchard site with trees until after some time has elapsed and the condition of the soil has been improved. Even the making of replants after an orchard has reached bearing age is usually a doubtful practice, though because of the unfavorable competition of the young trees with the older ones, rather than because of soil depletion.

An extreme case of old age in a peach tree is indicated in Plate X, which shows an Oldmixon Free tree in Caroline County, Maryland, which was fifty-four years old when the picture was taken. The tree lived for several years after that time.

The effect of actively stimulating vegetative growth either by tillage or the use of nitrogenous fertilizers, or both combined, may result in a material delay in the ripening of the fruit. So well is this recognized by some growers, that they definitely aim to extend considerably their "peach season" by these means even when only a single variety is planted.

MAINTAINING THE FERTILITY OF THE SOIL

Fundamentally, the methods of maintaining or increasing the fertility of the soil in a peach orchard are the same as those used in the culture of other fruits or general farm crops, except, of course, that so far as the latter are concerned there is an opportunity for crop rotations that are not possible in an orchard.

It is always far better to maintain the fertility of the soil at a high standard than to permit it to become depleted to such an extent that restoration is necessary. Good tillage

and the maintenance of an ample supply of humus or decaying vegetable matter in the soil will do much to keep it in a sufficiently productive condition for peach-growing. The application of manures or fertilizers, however, is not infrequently necessary for the best and the most profitable results. In fact, peach trees doubtless fail of the expectations entertained for them much more often from a lack of sufficient available plant-food in the soil than is commonly supposed. While a soil that is so fertile as to induce an extremely vigorous growth and rank foliage is not desirable, the opinion commonly expressed that almost any soil, however poor in fertility, is good enough for peaches is not supported by the best experience.

Tillage, cover-crops, and the use of manures and fertilizers comprise the peach-grower's agencies for maintaining the fertility of the soil in his orchard.

Other inter-relationships of the major operations in orchard management exist, but they may be passed over at this time.

CHAPTER VII

THE TILLAGE OF PEACH ORCHARDS

TILLAGE refers to the work done with the plow, harrow, cultivator, or such other implement as may be used in working the soil after the trees are planted. The word "cultivation" is commonly used in the same sense, but as it is also given a broader meaning in some cases, the term "tillage" is the more specific one in the present connection. The effects of tillage have been comprehensively summarized by Bailey[1] as follows:

(1) Tillage improves the physical condition or structure of the land, (*a*) by fining or comminuting the soil, and thereby presenting greater feeding surface to the roots; (*b*) by increasing the depth of the soil and thereby giving a greater foraging and roothold area to the plant; (*c*) by warming and drying the soil in spring; (*d*) by reducing extremes of temperature and moisture; (*e*) by supplying air to the roots (and thus, among other things, promoting biological activities that enhance soil fertility).

(2) Tillage may save moisture, (*f*) by increasing the water-holding capacity of the soil; (*g*) by checking evaporation.

(3) Tillage may augment chemical activities, (*h*) by aiding in setting free plant-food; (*i*) by promoting nitrification; (*j*) by

[1] "Principles of Fruit-Growing," 20th Ed., 1915.

hastening the decomposition of organic matter; (*k*) by extending these agencies (*h, i, j*) to greater depths of the soil.

(4) Tillage indirectly protects the plantation, (*l*) by destroying weeds; (*m*) by destroying insects and breaking up their breeding places; (*n*) by tending to reduce plant diseases, in the removal of host plants, burying of affected leaves and fruits, and the like; (*o*) by aiding in the keeping down of mice, rabbits, and other pests.

It follows as a natural sequence that if there is sufficient and suitable tillage to maintain the soil in the best physical condition and to conserve the soil-moisture well, the other objects named in this summary will probably also be realized. An orchard should be tilled, if at all, for the sake of the trees and their product, not for the sake of the tilling. If the soil conditions which are subject to influence by tillage exist in a particular orchard without it to an extent adequate for the needs of the trees and the production of good crops, then perhaps nothing is to be gained by tillage in that orchard so long as the results obtained are satisfactory and the trees remain in a vigorous, thrifty condition.

Too much emphasis can hardly be placed here on the importance of conserving soil-moisture, especially during the period of most active growth of the trees and the development of the fruit. The quantity of moisture required by the tree during this period is almost beyond belief. It should be remembered also that all mineral plant-foods are taken up by the tree in solution, being dissolved in the soil-moisture. An insufficient supply of moisture in the soil may mean, therefore, that the tree is not being supplied with adequate plant-food materials, or that it is getting them in a solution that is too concentrated, as well as the more evident effects that may be manifest in the wilting of the foliage in

extreme cases due to larger quantities of moisture being transpired through the leaves than is replaced by absorption through the roots.

The continuous clean tillage of apple orchards is a mooted point with many growers. The exponent of each of the different methods of maintenance, which include clean tillage, tillage and cover-crops, sod mulch, and the like, becomes skillful in adducing evidence, which to him is convincing, in support of his favorite system. The fact is not as well recognized as it ought to be that each system where effectively maintained in an orchard is an expression of the operation of fundamental principles. If clean tillage is the best system under certain conditions and the sod-mulch system proves best under other conditions, the important thing is to determine what the relation of the different conditions is to the results obtained.

A correlation of cause and effect, in other words the establishment of the principles that govern or determine the results, is not always easy, nor is it always possible with the present knowledge of what actually constitutes fertility in soils. The fact is more or less frequently observed, however, that clean tillage or tillage and cover-crops give entirely satisfactory results in some orchards where under a sod-mulch system the trees show evident signs of distress; and that in other cases the sod-mulch method of maintenance may give unmistakable evidence of superiority as compared with clean tillage or tillage with cover-crops.

The present conception of what constitutes fertility cannot be expressed in simple terms of available plant-food. It was a great advance when the soil physicist comprehended the importance of the physical condition of the soil in addition to the presence of certain chemical constituents. The

conception that the chemical activities necessary to fertility could not proceed except when the soil was well filled with humus or decaying vegetable matter was reflected in many ways in the improvement of agricultural conditions generally. The organic chemist has made it clear that the by-products of the growth of roots in the soil, in some cases at least, become poisonous or toxic to the plants themselves after a time, and the bacteriologist has developed the thesis that a fertile soil, in addition to being a laboratory where essential and intricate chemical activities are constantly going on, is also a medium in which bacterial life is active almost beyond man's comprehension. This, then, is the present idea of soil fertility — a combination of moisture (as affected by the physical condition of the soil), humus supply, chemical activities, bacterial and other biological activities, organic compounds (which may act adversely), and the presence of the essential plant-food elements.

It is obvious at once that there must be an interminable correlation between these various factors, and that they may react differently under varying conditions.

The real problem in tillage is so to control or manage the soil as to bring about such activity of all the biological and chemical forces that are related to soil fertility as will result at all times in their complete correlation in terms of the plant-food requirements of the trees. It is obvious that the problem is much involved and the means of control are often obscure, but experience has taught much with regard to practical methods of tillage.

With particular reference to peach orchards, there is comparatively little difference of opinion among experienced growers in regard to tillage. While an occasional instance of a peach orchard which has been successful for a long time

without tillage may be cited, the conviction of the best growers in practically all peach-producing sections is that thorough tillage is essential to the continued successful maintenance of an orchard, and that any other method, if long continued, is inevitably at the expense of the trees.

"Thorough tillage" does not mean the same to every grower. To one it may consist of plowing the orchard in the spring and harrowing it once or twice later in the season; to another, who has a very high estimate of tillage as a means of preventing the evaporation of moisture from the soil, it may mean going over the orchard with some tillage implement twice a week or twenty to twenty-five times during the growing season.

No arbitrary rules for tilling an orchard can be given. But if a grower keeps in mind the objects of tillage and understands the principles involved, there should be little difficulty in deciding on a rational plan of procedure.

Generally speaking, a peach orchard should be tilled throughout its entire life, beginning with the first season after the trees are planted. If, for the sake of economy or for other reasons, it is impracticable to work the entire area between the trees, it is usually feasible to confine the tillage for the first year or two to a relatively narrow strip along each row. But the width of the tilled strip should be extended each season, and by the third year the entire surface should receive attention. By that time in the life of a peach tree the roots are extending beyond the spread of the branches; and the entire space between the rows, where the trees have been planted the usual distances apart, is rapidly becoming filled with small rootlets and root-hairs through which moisture and plant-food in solution are taken up. The root development of peach trees, indicating

the position of the roots with regard to tillage, and the application of fertilizers are suggested in Plate IX.

Under what may be termed normal or standard conditions in most peach-growing districts the advice applies generally to begin the tillage in the spring as soon as the soil is in suitable condition to work. But in the case of bearing orchards, some of the wisest and most experienced growers prefer to wait until after the fruit has set before they begin, in the belief that the results of earlier tillage may influence adversely the setting of the fruit. The presence of a cover-crop, its character, and the needs of the soil with reference thereto are other factors that may influence the date of beginning the tillage. The handling of cover-crops is discussed in Chapter VIII.

Conditions should determine what the nature of the tillage shall be. If the soil is hard or if there is a cover-crop that has made considerable growth, it will be necessary to turn the soil with a plow and follow with a harrow, cultivator, or such other tillage implement as best suits the needs of individual orchards. If the soil is light, plowing in the spring sometimes may be omitted, when some type of cultivator is found adequate to pulverize thoroughly the soil to a sufficient depth. Whatever the details followed may be, they should be so directed as to keep the surface as level as possible. For example, if the soil is plowed toward the trees at one time, it should be turned away from them at a later plowing.

In general, the orchard should be gone over with some kind of tillage implement often enough to keep the soil thoroughly light and loose, or, in other words, in the condition of a dust or better a "granular" mulch, for a depth of at least three or four inches. If a crust forms on the

PLATE X. — An Oldmixon peach tree about fifty-four years old.

surface, or if the dust mulch becomes compact, evaporation of the moisture that is in the soil will become excessively rapid and an unnecessary and perhaps serious loss of moisture which is needed by the trees will occur. As the surface is made compact by rain, it follows that tillage is advisable, as a rule, after each rainy period or after heavy showers; also as much more frequently as the impaired condition of the dust mulch may make necessary. In irrigated orchards tillage should follow generally soon after each application of water.

Tillage operations are usually continued, except in special cases, until midseason, the middle of July or the first of August. By that time the growth of the trees for the season will have been largely made, fruit-buds for the next season's crop will have begun to form, the fruit of the midseason varieties will have completed a large proportion of its growth, and the later varieties will finish their development during a period when less moisture is required for the various functions of the tree than earlier in the season. Where cover-crops or green-manure crops are desired, they should be sowed, in many cases at least, by this time.

However, no arbitrary rules governing tillage operations can be stated, but if a grower grasps the fundamental principles which underlie the objects of tillage as summarized on pages 101–2, there should be little difficulty in making efficient application of them. It may not be possible — on the other hand, it probably will be impossible — for one to determine with definite accuracy what chemical and bacteriological activities are going on in the soil at any particular time or what in the way of tillage will best promote those activities for the optimum condition of the trees. But as a rule, the changes resulting from them are gradual and their effect

on the trees is also gradual, thus giving time and opportunity usually for the observing grower to correct or modify his tillage practices with a view to correcting any undesirable tendency in the behavior of the trees. So long as the trees in an orchard remain vigorous and healthy, make good annual growth, develop good foliage with rich, deep green color, and bear abundantly of well-colored and well-developed fruit, the evidence is conclusive that nothing is radically wrong in the treatment the trees are receiving. On the other hand, if the trees fail in any of these particulars, it may mean that the treatment is faulty at some point and should be changed. It may require some experimenting to locate the particular thing that needs modification.

TILLAGE IMPLEMENTS

Little need be said about tillage implements in this connection. The particular style or make of harrow, cultivator, or plow best suited to accomplish the ends desired of tillage should be used. The type of soil on which the orchard is located is perhaps the determining factor in the case, but as a rule the implement that gives good satisfaction in the tillage of other crops grown on the same type of soil will serve the purpose well. Usually a spring-tooth harrow, smoothing harrow, disk, or some of their numerous modifications, may be used to advantage.

As the trees become large, some of the extension types of tillage implements are advantageous, as they make possible the working of the soil under the branches without unduly crowding the team into the trees.

In one of the large mountain peach orchards in West Virginia, where the broken topography of the land requires

strong motive power for efficient work, the outfit shown in Plate XI has proved especially well adapted. The team of leaders is driven by a "jerk line," the driver riding the near pole horse. The man who rides the harrow not only serves the useful purpose of weighting it down, so that it will cut deep, but he also guides the harrow past the trees by properly adjusting the positions of its two sections. In this way the trees are rarely injured, and yet the harrow can be run very close to them. However, in this particular orchard the use of the harrow is usually preceded by two or three bouts with a light one-horse plow along each row of trees.

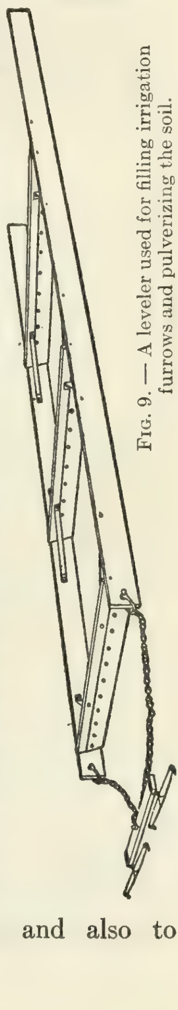

Fig. 9. — A leveler used for filling irrigation furrows and pulverizing the soil.

The leveler shown in Fig. 9 is also a very useful tillage implement in some orchard districts. Its use could doubtless be greatly extended to good advantage. Though of special importance in some of the irrigated districts for leveling the irrigation furrows, it is effective in crushing clods and in smoothing the surface of the soil. It is a home-made affair, consisting of two side pieces of 2-inch plank, 12 or 14 feet long and 7 or 8 inches wide. The crosspieces are 7 or 8 feet long. The lower edges of the crosspieces where they come in contact with the ground are protected with strips of iron or steel to prevent undue wearing and also to

give increased efficiency. Other details of construction are made sufficiently plain by the illustration.

Tractors are being used more and more for motive power in orchard tillage and generally with excellent satisfaction. Various types of tractors are now on the market, one of which is shown in Plate XI.

CHAPTER VIII

INTER–PLANTED CROPS

The term "inter-planted crop" is here used in its broadest sense and is intended to include any crop that is interplanted between peach trees for any purpose whatsoever. Peach trees may be themselves an inter-planted crop since they are used as "fillers" frequently in apple orchards.

The term is more commonly used in a restricted sense to mean a crop grown between the trees before they come into bearing, expressly for the money return, or its equivalent, which the crop is expected to make. In effect it is a means of reducing the cost of maintaining the orchard during the non-productive period of its existence. However, such a crop may serve a double purpose, yielding not only a financial return, but also accomplishing other important results ordinarily secured by planting certain crops with the improvement of conditions definitely in view. It follows, therefore, that there is no specific line of differentiation between an "inter-planted crop" in its restricted money-crop sense and one planted solely as an orchard-improvement factor. The terms "filler-crop" or "secondary-crop" seem to convey specific meaning in this connection, and will be used here to denote a crop that is "filled in" between the trees while they are small and during the years when they do not require the entire space, and are grown for the express

purpose of financial gain. Such a crop is "secondary" to the trees, while a crop grown during a certain period as an orchard-improvement factor is without reference to direct financial gain from the crop itself; it may be, and in fact often is, of primary importance in the welfare of the trees.

Inter-planted crops, therefore, may serve various purposes in a peach orchard. The terms by which they are commonly designated are partially self-explaining. They may be enumerated as follows: (*a*) Filler- or secondary-crops; (*b*) cover-crops; (*c*) green-manure crops; (*d*) mulch-crops; (*e*) shade-crops. These terms, excepting the first, are used more or less interchangeably (sometimes erroneously so), yet each one has its own special significance in orchard management. Moreover, the objects implied by these terms are attained largely by the use of the same crops, excepting those for which filler-crops are grown.

Briefly stated, these terms are differentiated about as follows: A cover-crop is one sown usually rather late in the season with a view, in part at least, to its furnishing a cover for the ground during winter. Such a provision is especially valuable where the winters are severe and the ground apt to be without protection from snow. A cover-crop frequently will prevent root killing by thus affording protection to the roots.

A green-manure crop is one grown primarily for the purpose of supplying humus to the soil. It may also serve the purpose of a cover-crop, and, in turn, a cover-crop adds humus to the soil. The term "cover-crop" is, therefore, the more comprehensive of the two, though when a crop grown primarily for green-manure purposes also furnishes protection during the winter, the terms become essentially synonymous.

A mulch-crop is one grown more or less permanently in the orchard, such as the various clovers, alfalfa, and the like. The usual plan is to cut the crop several times during the season, leaving all or a part of it on the ground to serve as a mulch. When mulch-crops are employed, the orchard is not ordinarily tilled or cultivated, excepting possibly where alfalfa is used, when a certain amount of early spring tillage to improve the alfalfa may be done. It is rarely, however, that a mulch-crop has any place in a peach orchard. Hence no further discussion of it is needed here.

A shade-crop is one planted, not primarily to supply humus for improving the physical condition of the soil, nor to protect the roots of the trees against winter injury, but for the purpose of shading the ground from the intense heat of the sun. The need for this is most apparent in some of the hot irrigated valleys in the inter-mountain states of the West where at times the reflection of the sun from the water used in irrigating, if run close to the trees, or where reflected from the surface of the bare ground, may be so intense as to injure the trees. However, a shade-crop may also serve every purpose of a cover- or green-manure crop or even a mulch-crop.

The practical utility of filler-, cover-, green-manure, and shade-crops in the management of peach orchards is now presented.

FILLER-CROPS

That a filler-crop is secondary in importance, from every standpoint of the orchard itself, has been indicated. Its use makes a system of double cropping with the trees as the primary crop. It is not expected, ordinarily, that a filler-crop will be of any direct benefit to the trees, unless

by chance they receive better attention than they would otherwise have. But since the tree roots do not at first occupy all the ground, it becomes possible to grow certain types of crops between the trees without detriment to them. The tillage given the filler-crop counts as tillage for the trees, hence the proceeds of that crop may pay, in part at least, for the maintenance of the orchard during its non-productive years. The use of a filler-crop is distinctly a business enterprise. However, by the third season possibly and rarely later than the fourth, if conditions are favorable, a peach orchard should produce a crop of fruit. After bearing begins, no filler-crop should be grown. Besides it has been pointed out (see Plate IX) that the roots occupy all the ground at a comparatively early age. After this time the trees should not be made to compete with another crop unless, as in case of a cover- or green-manure crop, it more than compensates for the competition in what is contributed to the welfare of the trees and the fruit.

Too often, however, in the use of filler-crops the greed of the grower results in his ignoring the fact that he is double cropping his land, and that the most important crop in reality is the trees, even though they apparently occupy but a small part of the area. Because of this, the grower expects practically as large returns from the secondary-crop as though there were no trees on the land. This is especially likely to be the case the first year or two when the trees are small. For example, if corn is the filler-crop, it is common for the grower to plant just as many rows of it, excepting the tree row, as he would were there no trees to be considered. He should, rather, leave a sufficiently wide space along the tree rows so that as the corn reaches its full height it will not in

any measure shade or interfere with the development of the trees. This principle applies without regard to what is used as a filler-crop.

The character of the filler-crop is of fundamental importance. The requirements of peach trees as to tillage have been discussed. Obviously the tillage requirements of the secondary-crop should be similar to those of peaches. The crop also should be selected with regard to its marketability. Small grains such as wheat should never be grown except as a cover- or green-manure crop to be plowed under in early spring. If grown to maturity, the small grains not only prevent tillage during the most important period for that operation, but they take large quantities of soil-moisture which ordinarily are needed by the trees.

Most hoed crops can be used for fillers. Beans, peas, tomatoes, cabbages, muskmelons, and other vegetables of like tillage requirements, also corn if properly handled, may be selected, depending on their marketability in the place where grown. Irish potatoes are used in some sections, but as a rule only where early maturity is insured. They are not desirable on general principles in the North or in other regions where late digging is made necessary by late maturity. The digging under some conditions might be equivalent to a late cultivation, the latter having a tendency to stimulate an unduly late growth of the trees.

While small-fruits such as raspberries and blackberries are sometimes grown in this way, it is inadvisable even though they require good tillage. The competition for soil-moisture is entirely too strong, often, for the satisfactory growth of the trees. Strawberries are objectionable in that they ordinarily are not cultivated much, if any, in the spring until after the fruit is harvested and this is when the trees

need cultivation most; they are cultivated late in the season when the trees should not receive it.

Peach trees themselves are sometimes used as a filler-crop, especially in young apple orchards. In certain sections a large peach industry has been developed almost entirely in this way, and the fruit from such sections has become a considerable factor in the market during certain periods in the season. But as the apple trees have developed and the peach trees have been removed, the peach industry of these regions has passed nearly out of existence; its complete passing is a matter of but a few years.

The practice of inter-planting peach trees in apple orchards is both condemned and advocated by growers of wide experience. Peaches so planted are often put on sites which, though good for apples, are less satisfactory for peaches. The results from the latter are, therefore, likely to be disappointing. Probably the most serious objection, fundamentally, to this course is that it places bearing and non-bearing trees on the same land, and even though different fruits, it follows that trees, especially young trees not in bearing, often require quite different treatment from those that are fruiting. Obviously, under such conditions some sort of a compromise treatment is necessary. As the apple trees are permanent, their welfare should not be sacrificed for the temporary advantage that might result so far as the peaches are concerned.

When the site is well chosen and equally good for both apples and peaches, it may be presumed that the returns from the filler trees will partially compensate for the cost of bringing the apple trees to the bearing age.

Where filler-crops are used, the grower should not lose sight of the fact that double demands are being made on

the fertility of the soil. If need be, he should fertilize the land accordingly. Otherwise, the growing of the filler-crop can only be to the material disadvantage of the fruit-trees.

COVER-, GREEN-MANURE, AND SHADE-CROPS

Because of the close similarity of these groups of crops and the objects for which they are used in orchards, they may well be considered together in the present discussion. The distinction between them, when it exists, has been pointed out in another place (pages 112–113).

Though clean tillage for peach orchards during the first part of the season or until some time in July is the general practice, the use of cover- and green-manure crops is of fundamental importance and in many cases even of necessity if the orchards are well maintained.

Doubtless the relation of these crops to the physical condition of the soil through the addition of humus represents their most important function. This interrelation of the humus-content of the soil to its physical condition, and in turn its physical condition to its fertility through the chemical and biological activities that are either promoted or retarded by this condition, are too well recognized, even though they may not be fully understood, to require extended comment here. It will suffice to establish the fact that peach orchards often need the ameliorating effects on the soil of cover- and green-manure crops and not infrequently suffer because of their lack.

It will help the reader who has to meet the problems incident to the use of these crops to have in mind rather definitely their more important effects on the soil and the part they play in successfully maintaining or improving its

producing capacity. These effects may be enumerated as follows:

1. The physical condition of the soil is improved when the cover- and green-manure crops are plowed in: (*a*) by giving more body to very light soils; (*b*) by preventing the heavier soils from cementing together or puddling.

2. Soils may be deepened by the action of the roots of some kinds of crops and by their decay when the crops are plowed in or the plants die at the end of their natural period of growth.

3. The humus thus added increases the water absorbing and holding capacity of the soil. Under some conditions and with some crops, the snows of winter are held in position, thus increasing the soil-moisture which in some sections is of much importance. The growing crops also tend to hold the rains, preventing a part of the run-off during heavy showers, thus increasing the amount of water that soaks into the ground.

4. The humus added by these crops tends to induce or promote chemical and bacteriological activities by means of which plant-food is made available for the use of the plants.

5. Where irrigation is practiced, it is made easier and more effective by the presence in the soil of liberal quantities of humus.

6. Because of the effects stated under item 1, among other things, the roots of the trees are better aërated, which is essential for vigorous, thrifty growth of tree.

7. The soil is dried out in the spring by the early growth of the hardy crops, thus making possible earlier tillage.

8. Late fall growth of the trees is checked by the growth of the crops, thus many times inducing the ripening of the

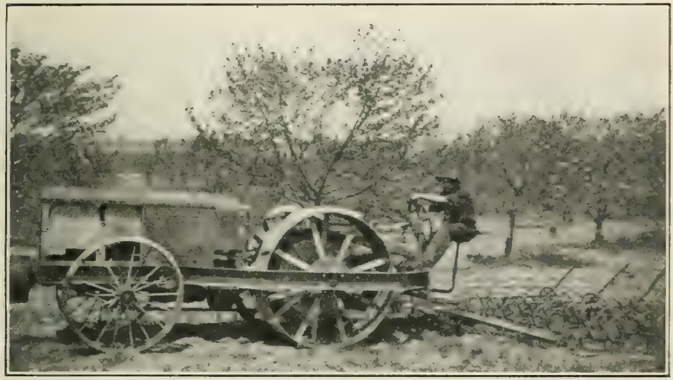

PLATE XI. — *Top*, a disk harrow and team for orchard tillage; *center*, a tractor used in tillage operations; *bottom*, soybeans inter-planted in drills as a green-manure crop.

wood. This is especially important where the winter cold is a factor, but of less importance in the warmer peach-growing regions.

9. The winter cover may protect the roots from injury.

10. Nitrates which are not required by the trees during the late fall and winter are taken up by the growing crops, thus preventing their loss. The nitrates are returned to the soil in the decaying humus.

11. Leguminous crops add nitrogen to the soil. The growing of such crops is usually by far the cheapest method of securing this important and costly plant-food.

12. In some cases cover-crops prevent erosion of the soil.

13. In regions where alkali troubles are a factor, they sometimes may prevent the salts which would otherwise come to the surface from becoming sufficiently concentrated to cause harm.

The wise use of cover- and green-manure crops presents many problems to the peach-grower. Perhaps the one which transcends all others is what crop to put in, and when, for the best results. The question is answered, if at all, in much the same way that a skillful physician prescribes for a patient. He knows the patient and his needs, and the remedies with which he has to work. The more completely the physician is possessed of this information, the more skillfully and effectively he can prescribe a course of treatment. In the same way, the better a peach-grower knows his orchard and its needs, and the means and materials at hand with which to work, the more successful, other things being equal, he makes the orchard.

It requires good judgment to know when to use these crops and when to omit them. In very dry falls when there is but little moisture in the soil, or in regions of limited pre-

cipitation where the trees habitually go into the winter with but a very low content of moisture in the soil, cover-crops ordinarily should not be used. To sow them would be still further to reduce an already small supply of soil-moisture (in case the seed germinated and grew), which might easily prove disastrous to the trees from their drying out unduly during the winter and dying as a result.

In some regions where peaches are an important crop but where the precipitation is habitually limited and no possibility of irrigation, the growers are facing a serious dilemma in that there is not sufficient rainfall to maintain the trees and grow a green-manure crop at the same time, yet they are facing the disastrous effects of a depleted supply of humus in the soil.

Cover-crops or green-manure crops fall into two distinct groups — leguminous and non-leguminous. The plants commonly used for the former include: cowpeas, soybeans, field peas, red clover, crimson clover, bur clover, bitter clover (*Melilotus indica*), hairy or winter vetch, and occasionally others. The more common non-leguminous cover- and green-manure crops are: rye, oats, buckwheat, rape, cow-horn turnips, millet, cane, corn, and some others. Which one or ones of these crops a grower should use in his orchard depends on the needs of the soil and other conditions.

The leguminous crops are nitrogen-gatherers. If more nitrogen is needed in the soil, as is very generally the case, a crop of this group obviously should be chosen. On the other hand, if the objects for which the crop is needed in the orchard do not include an increased nitrogen supply, one of the non-leguminous crops will serve the purpose. Sometimes a combination of the two types, as rye and vetch, is used to good advantage.

The time of sowing the crop will depend on conditions, the kind of crop to be used, the needs of the orchard, and perhaps the other work required in the orchard during the latter part of the season. If the crop used is one that is killed by frost, it usually should be sowed not later than the middle of July or at the time of the last cultivation of the orchard. In the case of cowpeas, soybeans, or other crop commonly planted in rows and cultivated, earlier sowing may be practicable. Then the tillage of the improvement-crop will also serve as tillage for the orchard. Plate XI shows a crop of soybeans planted in a peach orchard in this manner, while Plate XII shows one where cowpeas have been broadcasted.

On the other hand, if the crop is rye, vetch, rape, or any other that withstands frost and even makes good growth during the cool weather of late fall, it may be put in at any time from September 15th to November 1st, or perhaps even later in the warmer sections of the country.

Expediency will also determine in a measure when the crop should be planted. When possible, it may be wise to defer seeding until after the fruit is harvested.

While in apple orchards improvement- or mulch-crops are often sowed with a view to maintaining the orchard under a sod or mulch system for a period of years, such a crop is rarely sown in a peach orchard except to turn under the following spring at the latest.

In the case of a crop that lives over winter, if soil-moisture conditions permit, it is a common practice to allow it to make considerable growth in the spring before it is plowed under, thus increasing the amount of vegetable matter to put into the soil.

When buckwheat, cowpeas, or other crops that are killed by frost are used, they are sometimes left on the surface of the ground over winter or worked into the soil late in the fall either with a disk harrow or plow. It has been shown by the Ohio Experiment Station that substantially the same winter protection is afforded the roots if the crop is plowed under in the fall as when it remains on the surface.

A choice of improvement-crop to be used may be determined in some cases by special conditions that need to be met. For instance, the Nebraska Experiment Station demonstrated that millet was one of the most satisfactory crops available for the conditions in that state. It can be sown relatively late and still make a good bulk of vegetation. While it is killed by frost, it remains standing well and thus catches the snow and holds it from blowing off. The snow thus held not only serves as an excellent winter protection for the tree roots, but it adds materially to the soil-moisture supply when it melts. While the latter factor is unimportant, perhaps even undesirable, in some sections, in others, especially those in the drier portions of the country, it is greatly to be desired.

Shade-crops are sometimes of importance in the regions where irrigation is practiced. The bark of fruit-trees is sometimes injured apparently from the reflection of the hot rays of the sun from the water in the irrigation furrows, especially if they are run close to the trees. It has been suggested by Paddock and Whipple that such injury may also occur as a result of the reflection of the sun from the surface of the soil under some conditions.

To meet this situation the suggestion was made first by Paddock [1] that the shading of the ground during the

[1] Colo. Sta. Bull. 142.

active growing period of the trees by maintaining some kind of crop on the ground during that period for the primary purpose of shading the soil would obviate the trouble. This course evidently accomplishes the end in view, but in reality it closely approximates a mulch-crop system of maintenance which on general principles is objectionable in peach orchards. However, the most objectionable feature is perhaps the relation of the mulch-crop to soil-moisture. In irrigated sections this is of less concern than in non-irrigated areas, especially if water for irrigation is abundant.

Many of the crops used for cover- and green-manure purposes are suitable also for furnishing shade. Some of them can be grown in drills to advantage and cultivated so that the objection that shade-crops, because they occupy the land during the early part of the season and therefore prevent tillage, is not fully applicable. The grower whose trees may have suffered injury from the cause in question should keep in mind that he has recourse to the growing of crops that will shade the ground if such course seems desirable. At the same time such crops, if handled properly, will serve the purpose of green-manure crops.

It is only under rather unusual conditions that it is wise to permit a peach orchard to remain in sod or to go through a season uncultivated, particularly in non-irrigated regions. However, where an orchard is in excellent condition, the soil rich and well supplied with moisture, a temporary emergency which compels resort to some kind of mulch system may be without serious or irreparable damage to the orchard. Plate XII shows a peach orchard being carried over one season in a red clover sod. This was done merely for the purpose of reducing the expense of maintenance during a season in which there was little or no fruit. The owner assumed,

however, that this practice was doubtless at the expense of the trees.

Attention has been called to the relatively large number of crops that can be used for inter-planting purposes. The problem is perhaps complicated somewhat by the number. The grower, however, need not be anxious about the one selected so long as it is adapted to the climatic and other conditions under which he is working and at the same time meets the needs of his particular orchard.

The needs to be considered vary not only with individual orchards, depending on the soil conditions and the way the soil has been managed, but the needs are more or less regional. In parts of the country where the ground is habitually deeply covered with snow all winter, there is not the need of providing protection from extreme freezing that there is in regions where the winters are very cold and further characterized by little or no snow. The problem or the pressing need in some other region may be a cover-crop of such a character that it will hold the snow from blowing away from the orchard. A crop that will start into vigorous growth early in the spring may be the requirement in some places, in order thus to aid in drying out the soil. In other regions or under some conditions the trees may tend to grow too late in the season, and the need then may be a crop that will make vigorous fall growth which will check the trees and induce ripening of the wood.

If the trees need more nitrogen, a leguminous, rather than a non-leguminous, crop is the logical choice. In supplying humus to the soil, so far as known, one kind of crop, bulk for bulk, is as good as another.

Thus, a wise selection of a crop for inter-planting involves consideration from two well-defined standpoints: the

adaptability of the crop to the conditions where it is to be used, and the needs of the orchard that are to be supplied in the crop used.

With some crops, there is a choice of variety which is highly important; while in considering others, cost of seed or some other factor quite apart from the usefulness of the crop itself should determine the selection.

Another feature in regard to the use of leguminous cover-crops should perhaps have cautionary consideration, though its real import is not fully known. Hedrick[1] has called attention to the possible relationship that is not generally recognized between the roots of peach trees and of certain cover-crops when they grow in close contact with each other. In case of peach trees grown in large pots with oats, rye, blue-grass, and various other non-leguminous species, the trees ripened their terminal growth long before frost occurred, while trees similarly grown, but with legumes, including crimson clover, peas, and beans, held their foliage and the terminal growth did not mature until a frost occurred the first of November. On examination of the pots containing the trees, it appeared that there was no intimate contact of the roots of the non-leguminous plants with the peach roots, while the roots of the legumes were most interminably intermingled with the peach roots. Whether these trees were able in some way to make use of the nitrogen gathered from the air by the legumes is open to doubt, though perhaps suggested by the behavior of the trees.

It is not to be presumed that the roots of a cover-crop would intermingle with the trees' roots under orchard conditions in the same degree that they do when grown in a pot.

[1] *Rural New Yorker*, Vol. LXIII, No. 2864, p. 858.

Yet the possibility of peach trees not ripening as early as desired when the orchard is seeded to a vigorous growing leguminous cover-crop under some conditions is suggested, and according to Hedrick the opinion that a peach orchard seeded to such a crop might suffer more during the winter than with no cover-crop at all is reported to be confirmed by practical experience, though it does not appear to be a conviction commonly held by peach-growers. It is a matter, however, that growers may do well to keep in mind.

In order to help the peach-grower in deciding on the kind of cover- or green-manure crop that will best meet the needs he has to consider, the following notes on the characteristics and adaptations of the plants most widely used for these purposes are here given.

The different crops are mentioned below in the general order of their importance and the extent to which they are used. The order of arrangement is intended to be only approximate as showing in this way the crops which are widely used and those of regional or minor importance. The leguminous crops, those which gather nitrogen from the air, and the non-leguminous crops, are grouped separately.

Leguminous crops

As a rule, leguminous crops, to do best, need a fairly good supply of lime in the soil. They do not thrive on acid soils. Moreover, in growing any of the legumes where they have not before been cropped, the soil usually needs to be inoculated with the proper nitrogen-gathering bacteria for the particular crop that has been selected. Without such inoculation, unless the soil already contains the right kind of bacteria, the crop is likely to prove a failure and in any

event to make only a very small growth compared with that of suitably inoculated plants.

Cowpeas.

Probably no other crop is grown so extensively for orchard cover- and green-manure purposes as the cowpea. It is used practically throughout the peach-growing sections, excepting possibly the more northern districts. This crop is especially important throughout the middle and southern latitudes. It is killed by the first frosts in the fall, hence is not to be used where an early spring growth is desired, and where winter protection is necessary, it may be less effective than a crop that lives through the winter, though the mass of herbage furnished by the cowpea and left on the surface of the ground or even plowed in during the late fall furnishes excellent protection, as has been shown by the Ohio Experiment Station.

In some sections cowpeas are turned under as soon as they are killed by frost, and rye is sowed to furnish a winter cover and an early spring growth. Grown for soil improvement purposes primarily, the seed is commonly put in at the last cultivation of the orchard, the middle of July or early August, about 1 to $1\frac{1}{2}$ bushels of seed to the acre being used if sowed broadcast. The seed is usually covered in this case by harrowing.

When it is desired to grow also a crop of seed, earlier planting according to the region and variety may be necessary. In this case it is better to plant in drills about $3\frac{1}{2}$ feet apart as early as may be necessary to insure the maturing of the seed. By adopting this course, it is possible also to continue the cultivation of the orchard. Planted in drills,

only about one-half the quantity of seed is needed as when sowed broadcast. However, the size of the seed varies greatly in different varieties, and the smaller the seed the smaller the quantity that needs to be used. Seeding may also be done with a grain-drill, in which case about two-thirds the quantity of seed should be used as when broadcasted. About 3 pecks of the smaller-seeded varieties such as New Era and Iron will suffice.

When cowpeas are used to maintain the soil in good condition and with no special reference to definite improvement, it may be practicable to cure the tops for hay, since from 25 to nearly 50 per cent of the total dry matter remains still available for soil maintenance in the roots, stubble, and fallen leaves. If the hay is fed and the manure returned to the orchard, but little of the value of the crop for soil improvement is lost.

There is considerable preference in varieties of cowpeas for orchard purposes. The Whippoorwill is a standard vigorous sort much grown. Wonderful is very vigorous, making a large mass of herbage, but maturing late and seeding only very lightly. New Era is one of the earliest maturing varieties and, therefore, is desirable for the more northern sections where cowpeas are used, though it does not make as much growth as the later sorts. The Groit is similar to New Era but considered preferable by some. Other good varieties for orchard purposes include Clay, Taylor, and Red Ripper, especially where the growing of seed is not an item.

The Iron is resistant to nematodes and wilt disease and for this reason has attained considerable prominence and is to be especially recommended in regions of the South where that parasite is known to be serious. However,

it is one of the more desirable sorts even aside from these features. The Brabham is also usually resistant to nematodes.

While under California conditions summer green-manure crops are usually undesirable, when other considerations are subservient to the improvement of the soil, the Whippoorwill cowpea has proved to be one of the most desirable crops for this purpose.[1]

Hairy vetch (*Vicia villosa*).

This vetch is also known as Russian, Siberian, and sand vetch, the latter name suggesting its ability to grow well on very sandy soil. The term "winter vetch" is also commonly given to it, but as it is applied also to strains of the common vetch it is better to avoid its use in this connection.

In recent years the hairy vetch has come into wide use as a cover-crop for orchards in nearly all parts of the country, especially where a leguminous crop that will live over winter and begin growth early the following spring is needed. This plant survives the winter both North and South, as few of the legumes which quickly make a large growth of herbage will do. Moreover, it "succeeds well on sandy soils, but can be grown on any well-drained land. It is markedly drought-resistant, often making a good crop under dry conditions where common vetch fails. It is quite resistant to alkali and will germinate well in soils too alkaline for most legumes."[2] These and other characteristics have brought hairy vetch into high favor as a cover-crop with fruit-growers in nearly all parts of the country, though

[1] Bur. of Plant Ind. Bull. 192, p. 124.
[2] Farmers' Bull. 515, p. 17.

the common vetch appears to be preferred in Oregon and California.

If not sown too late, even in the North, hairy vetch will make considerable growth in the fall; it forms an excellent cover for the ground during the winter and starts into growth as does rye very early in the spring. By the time the soil is dry enough to work, particularly in those regions where a heavy snowfall or copious winter rains supply abundant moisture, a heavy growth of herbage has been made and is ready to be plowed under. In many essential particulars, therefore, hairy vetch is an almost ideal cover-crop when a legume is desired.

Seeding may be done over a rather long period but where grown for the first time the inoculation of the soil with nodule-forming bacteria is of much importance. In the far South seeding any time from the middle of September to December will suffice, while in middle latitudes the dates advance a month. In the North seed is usually put in during the last half of July and in August. Seeding should not be delayed much later than the first of September.

For cover-crop purposes, seeding broadcast and harrowing in is the common practice. Sometimes the vetch is mixed with rye, oats, or wheat and put in with a seed-drill. Where it has not been grown before and is sowed alone, at least 25 or 30 pounds of seed to the acre should be used if broadcasted.

For cover- and green-manure crop purposes, hairy vetch is probably used more often with oats, wheat, barley, or rye than alone. Used by itself it mats down rather closely to the ground, but with either of the grains named it stands erect. Twenty or 25 pounds of vetch seed and one bushel of rye to the acre make a good combination. In the South

or where it is not important to secure a heavy growth in the spring, a bushel or more of oats may be used instead of rye.

The high cost of seed has doubtless prevented an even more extensive use of hairy vetch for orchard purposes. However, it is probably practicable for many fruit-growers, after they get a start, to grow enough seed for their own use. Sometimes it is possible to leave narrow strips of vetch in the rows between the trees without plowing it under, with a view to its forming seed. Where the seed matures in this way in the spring and falls to the ground it will germinate in the late summer or early fall.[1]

Common vetch (*Vicia sativa*).

The range of usefulness of the common vetch for orchard purposes is relatively restricted. It is suitable for fall seeding in the southern portions of North Carolina and Tennessee and in the tier of states immediately to the southward and westward, including the most of Arkansas and Louisiana, and adjacent areas in northwestern Texas and southwestern Oklahoma; also on the Pacific coast west of the Cascade and Sierra Nevada Mountains. It has also been used with satisfaction in eastern Washington.

For cover-crop purposes common vetch is used more on the Pacific coast than elsewhere, though there is no apparent reason why it should not be satisfactory in the South. The plants withstand remarkably well the tramping incident to harvesting a crop of fruit.

In the West it is generally seeded either broadcast or with a drill in September or October, and commonly mixed with oats. This combination is especially recommended both

[1] Farmers' Bull. 529, p. 7.

in California and in some parts of Oregon. O'Gara in Oregon recommends seeding the last of August or early September with a mixture of 70 to 90 pounds of vetch seed and 30 to 40 pounds of winter oats, the smaller quantities being used if the seeding is done with a drill. Others recommend a somewhat lighter seeding of 40 to 60 pounds to the acre when used alone.

Though common vetch does not survive the winter where the temperature drops much below 15°, it continues to grow more or less nearly all winter in the milder portions of the Pacific coast regions, and by February or March a large mass of vegetation is available for turning under.[1] On the other hand, hairy vetch does not make a good winter growth under these conditions.

Crimson clover.

The term "scarlet clover" is also commonly applied to this plant. For many years it has been used for orchard purposes in certain parts of the Atlantic seaboard, especially in New Jersey, Delaware, and the Eastern Shore of Maryland, but in more recent years it has been grown in increasing areas in North Carolina, Alabama, and other Coastal Plain and Gulf regions. It is not hardy enough to insure its living through the winter in New England, New York, and other northern sections; but when it does survive it grows well.

It is an annual plant and thus unlike most of the other well-known clovers. It makes most of its growth in the cooler parts of the season, — fall and spring. Were it not that it is often rather difficult to secure a stand, it would doubtless be used much more extensively and widely than

[1] Farmers' Bull. 529, p. 4.

Plate XII. — *Top*, red clover used as a mulch-crop in a peach orchard; *bottom*, cowpeas broadcasted as a green-manure crop.

at present. If it becomes dry after seeding, a poor germination may be expected, or if the seed germinates, the plants are killed quickly by lack of moisture. They also easily succumb from too intense heat. Where there is lack of moisture, hairy vetch is preferable.

When a good stand of crimson clover is secured, it makes almost an ideal crop for orchard purposes, the uncertainty in this respect being its one weak point. However, it does well when once fairly started on most soils excepting those that are very poor and lacking in humus, and stiff, hard clays, neither of which are desirable peach soils.

In Delaware and adjacent areas the seed is broadcasted and lightly covered by harrowing. About 15 pounds of seed or a little more to the acre are generally used. Seeding is done from about the middle of July through most of August, though if sown too late it will not make growth enough before cold weather.

Under favorable conditions, it should make considerable growth in the fall, which is actively renewed early in the spring. A good mass of herbage may be expected ready to turn under in the spring by the time cultivation needs to be resumed.

It is sometimes considered an advantage to seed with rye, oats, or some other small grain, using 10 to 15 pounds of crimson clover seed and a bushel of the small grain to the acre. It is also recommended to mix about a pound of rape or cowhorn turnip seed with the crimson clover seed with the idea that the plants of the latter as they grow will furnish protection to the weaker and more tender clover plants while they are very small.

It is also practicable in some cases, in turning under the clover, where it has made vigorous growth to leave some of

the heads sticking up between the furrows or in unplowed areas between the trees in the rows with a view to such plants maturing seed and reseeding without sowing by hand. In some instances satisfactory crops have been obtained in this manner year after year and with practically no expense.

Soybeans.

The soybean has not been very much used heretofore in orchards as an inter-planted crop for any purpose. As a cover- or green-manure crop for peach orchards, it fills in general very much the same needs as the cowpea and in some directions has a wider range of usefulness. Southward its culture corresponds well with the cotton-belt; northward, with the corn-belt. It is also recommended for California conditions where a summer cover-crop is desired. Light frosts in the fall that kill cowpeas do not injure soybeans, though they do not withstand severe frosts. Moreover, the seed germinates at a lower temperature and may be planted both earlier and later than the cowpea.

In sandy soil, where clover frequently fails, this crop as well as cowpeas has been found to do well. Where it has not previously been grown, inoculation of the soil with the proper nodule-forming bacteria is necessary. It is also more drought-resistant than cowpeas. The seed is sown either broadcast, using 1 to 1½ bushels to the acre, with a grain-drill, using about the same quantity of seed, or in drills 28 to 36 inches apart, requiring about half the quantity as when seeded by the other methods. If the surface of the soil packs a little, however, after seeding, the plants may have difficulty in coming up, while cowpeas under the same conditions would grow readily. For this reason,

especially, where the soil is heavy, a poor stand is sometimes secured. Shallow covering of the seed, not more than an inch, unless the soil is very light and loose, is advised. The seed varies in size with different varieties, hence the rate of seeding by the same methods will obviously vary somewhat on this account.

There are several varieties which are especially suited for use in orchards. Ito San and Ebony are early sorts, maturing at the Connecticut Experiment Station in 104 to 118 days; Wilson and Peking under the same conditions reached maturity in 120 to 124 days, and the Hollybrook in 130 to 135 days.

Other varieties that may be considered standard are mentioned as follows: Mammoth, one of the largest and one of the latest sorts; Guelph, about ten days later than Ito San; Buckshot and Ogernaw, both earlier than Ito San and also very dwarf sorts, and because of these characteristics they may be planted farther north than most varieties; Wisconsin Black, grown some in Wisconsin and Michigan; and some of the newer sorts of promise, Meyer, Austin, Riceland, and Haberlandt, the latter about a week later than Ito San. Naturally the early maturing varieties do not make as much growth as the later sorts, but for northern regions where the growing season is short they should generally be used unless the planting is done early in drills.

Velvet beans.

This plant, perhaps in some of its forms better known as a vine for growing on porches and for making screens by training on trellises, is used more or less as a soil-improvement crop in the Gulf states and in the Coastal Plain region northward as far as and including North Carolina.

It is also recommended as a summer green-manure crop in California. On account of its climbing habit and its consequent tendency to take possession of the trees, it is objectionable for use in orchards, though by taking a little pains in seeding and with a small amount of attention later serious annoyance from this cause may be avoided. Perhaps its most important claim for favor in orchard management in the region to which the crop is best adapted is its reported freedom from the attacks of nematodes.

There are a number of different varieties recognized, of which the Hundred-Day Speckle is one of the earliest maturing. Others are Florida Velvet which is an especially late variety, Chinese, Wachula, and Yokohama.

Velvet beans require a long season in which to mature, hence early seeding is necessary if seed is to be produced. The rate of seeding varies with the method, from 1 to 2 bushels being used if broadcasted. Planting in drills or in hills about 2 feet apart in rows 4 feet distant is recommended. The latter is advised in order that cultivation may be given. In hills a bushel of seed will plant three acres or more. In Florida planting is done in March or April, in North Carolina a month later, though for orchard purposes when the maturing of seed is not a factor, later planting may be practiced.

Field peas.

Though not much used in orchard management, field peas have possibilities. In comparison with other legumes they may be no better, but they offer an alternative in many regions with which the orchardist should be familiar.

As a winter crop, that is one to remain green and in a more or less growing condition throughout the winter, peas

are adapted to a rather narrow belt which includes northern Florida, southern Georgia and westward, taking in the southern half or more of Texas and to the Pacific coast, with most of California in the area. The New Mexico Experiment Station [1] reports that when seeded during the fall months, the vines were too succulent and tender to survive the winter, but when seeded any time from December to March the growth was not injured and a good quantity of herbage was available for turning under by the middle of May.

Probably field peas have been used more for orchard purposes in southern California, in the citrus groves, than elsewhere. O'Gara reports favorable results in the Rogue River Valley in Oregon when used as a spring crop for orchard purposes. Moreover, seeding may be done in most parts of the country at the time of the last cultivation in July or August, but except in the far South and in California the vines will be killed late in the fall by low temperatures, though light frosts will not injure them. The vines decay quickly and leave the soil and subsoil in excellent condition.

The large vigorous growing Marrowfat varieties, such as Canadian Beauty, Arthur, Paragon, Wisconsin Blue, and others, are suitable for orchard purposes.

About 2 to $2\frac{1}{2}$ bushels of seed to the acre are required when broadcasted, though $3\frac{1}{2}$ bushels of the very large-seeded varieties are needed, while $1\frac{1}{2}$ to 2 bushels of the small-seeded sorts will suffice. Grain-drills are sometimes used in seeding, in which case a smaller quantity of seed is required. The seed should be covered from 2 to 4 inches deep, depending on whether the soil is heavy or light.

As the vines mat down very densely, it is an advantage

[1] Bull. 99.

in many instances to mix the peas with oats or rye — the latter in the North where a spring growth is desired. Where this is done, about 1 bushel to the acre of the small grain is used with 1 to 2 bushels of peas, depending on the size of the seed.

Red clover.

With red clover may be considered also Alsike clover, Mammoth clover, and types of similar habits of growth and characteristics. These clovers are grown principally in a territory east of eastern Kansas, Nebraska, and South Dakota, and north of the southern boundary of Virginia, Kentucky, and Missouri. This area includes roughly somewhat more than the northeastern quarter of the United States. Small quantities are grown in the northwest and in other parts of the country, but in these districts the total is inconsiderable.

While these clovers, especially red clover, make a most excellent cover- and green-manure crop under some conditions, especially in apple orchards, it may be questioned whether they have any place as a rule in peach orchards. In habit of growth the roots of these plants are biennials, that is, they live two seasons. Therefore, they are likely not to make very much growth if seeded in midseason after orchard tillage ceases, nor do they grow rapidly enough in the spring to permit of very much growth before tillage should be resumed. It is in orchards where a mulch-crop is desired that the biennial clovers find their greatest usefulness in orchard maintenance. As indicated in the chapter on tillage, it is rarely that a peach orchard should be grown under the mulch system. However, in exceptional cases in which the trees are making too much growth or when the reduction of the expense of maintenance is imperative, a mulch-

crop may be endured for one season. (See page 123 and Plate XII.)

Seeding may be done either broadcast or with a grain-drill and covered $1\frac{1}{2}$ to 2 inches deep in light soils or about 1 inch in heavy soils. Failure sometimes occurs from not covering deep enough. About 10 to 15 pounds of seed are used. It is usually put in at the last cultivation in northern orchards or during July, but in the more southern clover districts August or early September will do, that is, after the intensest heat of summer is past. If it is merely to obtain a good catch seeding "six weeks before the first frost" serves as a general guide, but more fall growth is likely if it is done a little earlier.

It is doubtful whether a crop like red clover should ever be allowed to remain in a peach orchard over more than one season before being plowed up. During that season, the growth, if fairly vigorous, should be mowed two or three times, and left in the orchard as a mulch or made into hay, as conditions appear to justify.

Alfalfa.

For use in maintaining peach orchards, alfalfa occupies something the same place as red clover, yet its use implies even more than does that of red clover in a mulch-crop system of management. In the irrigated valleys of the West where shade-crops appear to be of importance and where irrigation water is sufficiently abundant to eliminate any question of an adequate supply at all times, alfalfa may serve a very useful purpose when grown to shade the ground in summer. On the other hand, the Arizona Experiment Station reports decidedly harmful effects of alfalfa in a peach orchard by retarding the growth of the trees.

In the irrigated fruit regions of the inter-mountain and Pacific Coast states where ill effects of continuous clean tillage are appearing, the use of alfalfa as a mulch-crop is being rapidly extended, though not in peach orchards to the same extent as in those of most other kinds of fruits.

About 30 pounds of seed to the acre is recommended for humid regions and about one-half as much in irrigated sections. The directions and time for seeding clover apply to alfalfa, except that as a mulch-crop early spring seeding is practicable. However, advantage should be taken of any local experience in seeding which has proved successful. The best time and conditions for seeding vary more or less in different parts of the country.

Bur clover, button clover, Japan clover or Lespedeza, bitter clover, sweet clover.

These legumes may be mentioned in the present connection merely to call them to the attention of peach-growers as possible alternatives when for any reason the legumes more widely used in orchard maintenance are not available. Each of them has possibilities for use in soil improvement, but at the present time they are not widely used as cover- or green-manure crops in orchard practice. In this connection, it is important to point out the geographical range of these different plants.

Bur clover, of which there are several forms, is an annual plant adapted rather definitely to the area south of the range of red clover though not including much of Florida and extending westward to include the eastern half of Texas. It is also grown west of the Cascade Mountains in Washington and Oregon and throughout the most of California, where one of its forms (*Medicago hispida denticulata*) is probably

used as a winter cover-crop in orchards more extensively than elsewhere in the United States, though it is also used for soil-improvement purposes quite extensively in the South. Fall seeding, using 15 to 20 pounds of hulled seed to the acre, is the practice. If in the hull, 3 to 6 bushels are necessary. It may be so handled after the plant becomes established that it will reseed itself.

Button clover, like bur clover, is an annual. It is adapted to all the Gulf Coast region extending northward to about the center of Georgia, Alabama, Mississippi, nearly all of Louisiana, and the southwestern part of Texas; also to southwestern Arizona, southern California, and a narrow belt extending along the entire Pacific Coast to northern Washington. The directions for seeding are the same as for bur clover. Button clover is decumbent in habit of growth, hence is sometimes seeded with one of the small grains.

Japan clover or Lespedeza is an annual plant which in its range of adaptability extends from the extreme South northward to the latitude of southern Pennsylvania and northern Missouri and westward to central Texas and western Oklahoma. Its greatest usefulness in this area is for pasturage, though it is cut for hay in some localities. It has not been much used in orchards, being less valuable, probably, than other available legumes. It will reseed itself if properly handled. Fifteen or 20 pounds of seed are used in the first sowing. Seeding if used for orchard purposes should be done in the fall.

Bitter clover (*Melilotus indica*) is used as a winter cover- and green-manure crop in orchards in California where in the southern part of the state in particular it appears to be very satisfactory for this purpose, especially in the citrus

groves where in some respects it is better than common vetch which heretofore has been used more extensively than any other plant as a winter cover-crop. In southern California, if the crop is to be plowed under in March, seeding broadcast should be done by the middle of October, but where later plowing is practicable the seed may be put in any time, up to the middle of December. From 20 to 35 pounds of seed to the acre should be used, the wide range being due to the variable germinating quality of the seed.[1]

Sweet clover, in its several forms or species, is widely distributed throughout the country. While grown in most of the humid and irrigated regions, it is also grown successfully under the dry land conditions that characterize the Great Plains area where few legumes thrive unless irrigated. Its ability to thrive in soils that are so hard and stiff as to be nearly unworkable is noteworthy. The large, deeply penetrating, fleshy roots with the numerous nitrogen-gathering nodules which it habitually develops when the soil once becomes inoculated with bacteria, together with the large quantity of herbage which it makes, give it special value under some conditions for soil-renovation purposes.

There are two species, *Melilotus alba* and *M. officinalis*, the latter being a yellow-flowered form. The former, however, is the more common. It is an upright, much branched perennial, while the yellow-flowered form is decumbent. Bitter clover (*Melilotus indica*) above referred to is also grouped by some with the "sweet clovers," but as it is an annual, its use in orchards is on quite a different basis.

Since the most successful seeding of sweet clover (*Melilotus alba*) is done in the spring and when sowed in the fall only a small root system develops, the characteristics of

[1] Calif. Exp. Sta. Circ. 136.

this plant do not fit it well for use in peach orchards, unless for the purpose of overcoming some especially difficult soil condition enough can be gained by letting the crop occupy the land throughout the next season to justify such a course. However, it makes an early vigorous spring growth which could be of value for plowing under as soon as it is desirable to resume tillage.

The fact that sweet clover is resistant to alkali in a rather marked degree is important in some instances, though alkali soils are not suitable for peaches.

Usually in seeding for forage crop purposes from 10 to 20 pounds of hulled seed to the acre are used, the smaller quantities being used in the irrigated regions. It frequently escapes cultivation, growing by the roadsides and in waste places.

Other legumes.

While various other legumes are used in the management of orchards, they are of regional value for the most part and serve some local purpose or offer an acceptable alternative. Many times the relative cost or availability of seed will determine the choice between crops, or some factor other than the characteristics of the crop itself will fix the choice.

Non-leguminous crops

From the standpoint of orchard maintenance, the non-leguminous plants used as cover- and green-manure crops serve the same purpose as do the legumes, except with regard to increasing the supply of nitrogen. The non-leguminous crops supply humus, give protection to the roots, prevent soil erosion, check the growth of the trees in the

fall when the new wood should ripen for winter, and the like. Perhaps on account of the physical characteristics of a number of the legumes commonly used, they may accomplish these ends more completely than most of the non-leguminous ones that are generally used for these purposes.

Though the nitrogen supplied through the leguminous crops is very much more often needed than otherwise, there are conditions when plants of this other group are exceedingly useful. The more important non-leguminous crops with which the orchardist has to do in this connection are here mentioned, together with their special points of usefulness.

Rye.

Undoubtedly rye is the most extensively and widely used non-leguminous plant for orchard cover- and green-manure purposes. Generally speaking it may be used in all the peach-growing regions, yet as a grain crop it is of much greater importance in the eastern half of the United States than in the western, though but little grown in the far South. It is often used on very poor soils as a forerunner of legumes, most of which require a soil moderately well supplied with humus.

It may be sowed late in the season if so desired; it remains green throughout the winter, even growing more or less in the milder sections; it starts very early in the spring, making rapid growth, hence furnishing a good supply of herbage to plow under as soon as it is desirable to resume tillage. It thus meets well nearly every need of a winter soil cover.

It is said that, as a general rule, seeding broadcast or with a drill, using $1\frac{1}{2}$ to 2 bushels of seed to the acre, may be

done ten weeks before the ground freezes. Relatively later seeding, however, is practicable, fairly good success being reported from sections as far north as central New York when seeded the first of November. As a rule, however, seeding for orchard purposes as late in the season as this is rarely necessary or desirable.

As noted elsewhere, rye is frequently used in orchards when mixed with various legumes.

Oats.

Oats are not extensively used in orchards though sometimes made to serve in place of rye, either in the South where the mildness of winter makes it possible for them to continue growth late in the season; or, if in the North, where the growth that is made during the fall serves the desired purpose. Oats do not survive the winters of the North. Late summer or early fall seeding is satisfactory, depending on the region, about 2 or $2\frac{1}{2}$ bushels of seed to the acre being required.

Buckwheat.

Next to rye, buckwheat is probably used in orchard practice more than any other non-leguminous crop. It is killed by the first frosts but it grows rapidly, seeded in midsummer when tillage ceases for the season, and it leaves the soil in good condition when the herbage becomes incorporated in it. The seed is usually broadcasted, $\frac{1}{2}$ bushel to a bushel to the acre being used.

Rape, cowhorn turnips.

Both of these crops are frequently used for the supplying of humus in orchard soils. The seed is put in broadcast in

late summer at the rate of $1\frac{1}{2}$ to 3 pounds to the acre. Considerable growth will usually develop before the plants are killed by the hard freezes of late fall. Ordinary frosts do not injure them. They leave the soil in fairly good condition and may be of considerable value. Perhaps they are used more often than otherwise with a view to turning hogs into the orchard late in the season. Under some conditions this course is practicable, though the running of hogs in a peach orchard should be done very guardedly, if at all.

Millet, corn, cane.

These crops have a certain range of usefulness for orchard purposes. They supply a considerable amount of humus if seeded broadcast in midsummer, though they are killed by the first frosts. Of these crops, millet has some advantages, the German millet on account of its vigor of growth being preferable to the smaller-growing forms. It should be seeded broadcast about six weeks before the first fall frost is expected, using from 1 to $1\frac{1}{2}$ bushels of seed to the acre. If seeded earlier, the plants are likely to mature seed which may give annoyance the next season. Millet is killed by the first frost, hence its activities then cease.

Some results with these crops, also rye and oats in comparison, as reported by Emerson,[1] are illuminating. The cover- and green-manure crop problem in Nebraska is somewhat peculiar, yet typical of a considerable range of territory which is characterized by limited rainfall and the resulting acuteness of the soil-moisture factor; comparatively severe winter temperatures, frequently with little or no snow to protect the ground; by a tendency, some seasons at least, to rather late tree growth; and by the ever present need of

[1] Nebr. Exp. Sta., 19th An. Rept. and Bull. 92.

maintaining a good supply of humus in the soil especially in connection with the moisture factor. These conditions require particular effort in the direction of checking tree growth so that the wood will ripen before dangerously low temperatures occur; supplying a protective covering for the soil, which among other things will catch and retain the snow and the winter rains; and the conservation of soil-moisture.

It was found from the work at the Nebraska Station that with peaches, rye as a cover-crop was disastrous because of its long-continued growth in the fall and its depletion of the soil-moisture to the point at which the trees suffer severely thereby during the winter. A considerable proportion of the trees died. Oats were less objectionable than rye, since they ceased to grow somewhat earlier than rye, being killed by low temperatures. Examination of the soil-moisture at various times revealed that it was appreciably higher in the oat plat where few trees died than where rye was used.

The best results, however, were where millet, corn, and cane were used, crops that were killed by the first frost, and which, therefore, ceased to draw on the moisture in the soil after that time. These plats contained a higher percentage of soil-moisture than the oat and rye plats and the trees came through the winter in a correspondingly better condition.

Of these crops, the millet proved most nearly ideal. The seed germinates readily; a large amount of growth is made which is available to plow under for humus; it forms a fairly good cover for the ground; it stands up well enough after being killed by the frost to catch the snow and prevent it from blowing away; it checks the growth of the trees at

the time it ought to be checked, giving them time to ripen before hard freezes occur. All are essential characteristics for a cover-crop where the conditions to be met are similar to those enumerated above.

Other cover-crops

Numerous other crops than those named are used in peach orchards. Many of them are of value locally, but the ones mentioned meet a wide range of conditions. They are typical. In this connection, weeds, if they are annuals and not obnoxious in any way, may and often do serve a useful purpose. In a measure they do what any non-leguminous cover-crop does in supplying a winter cover for the soil, protecting the roots of the trees, and in making humus.

CHAPTER IX

FERTILIZERS FOR PEACH ORCHARDS

THE peach needs every kind of plant-food that other plants and all plants need. The proportion of the different food elements and the actual amounts required by different plants vary somewhat, but perhaps not as greatly as is commonly supposed. But even a determination of the amounts of plant-food, both actual and relative, taken up by a tree does not serve to direct the practical, wise, and economical use of commercial fertilizers.

All plants in their growth require at least ten food elements. These are: carbon, hydrogen, oxygen, nitrogen, potassium, phosphorus, sulfur, calcium, magnesium, and iron. Three other elements, sodium, chlorin, and silica, may be used by plants. The first three named make up 90 to 98 per cent of green plants. Nitrogen comprises .2 to 1.5 per cent. All the others, totaling from 1 to 8 per cent of the plant's substance, are termed the ash constituents, since they remain in the ashes when the plant is burned.

Carbon, hydrogen, and oxygen are gases which plants obtain from the air and from water in unrestricted quantities. Nitrogen is also a gas and comprises about three-fourths of the air, but plants as a rule cannot take it in this form direct from the air. It must be combined in the soil with other substances, preferably in a form termed a "nitrate," or as ammonia. It is taken up in these forms from

the soil by the roots. Leguminous plants through the action of the bacteria which inhabit their roots are able to use the free nitrogen from the air, hence their value in enriching soils in this plant-food element.

It is universally recognized by the soil chemists and others that all ordinary soils contain enough of all the elements above enumerated except three to enable them to produce maximum crops indefinitely. These exceptions are: nitrogen, which very frequently is not contained in the soil in combined form in adequate quantities, potassium, and phosphorus; or, expressed in the more familiar terms of the fertilizer trade, nitrogen (or ammonia), potash, and phosphoric acid. Calcium, in the form of lime, may be needed in larger quantities than it occurs, but for quite secondary effects rather than as a direct plant-food. Substantially, then, in the solution of the fertilizer problem, the peach-grower is concerned only with these three elements, nitrogen, potassium, and phosphorus.

With this approach to the matter it might seem that a chemical analysis of the tree in all its parts compared with a similar analysis of the soil where the tree was growing would show what was lacking, and the question of what fertilizer to use would be easily and quickly answered. But this is not the case. A chemist might make these analyses, and those of the soil might show every element of plant-food present in almost inexhaustible quantity, and yet in actual experience it might be entirely possible that trees growing on the soil analyzed would show every indication of, and in fact actually be in, a depleted, starving condition — a case of the soil analyzing very rich in all the plant-food elements, yet unfertile and unproductive. Such instances are not only not hypothetical, but very common.

On the other hand, a soil may analyze low in plant-food elements yet prove to be very productive.

The whole difficulty here rests in the fact that the methods of analysis known to the chemists do not approximate those used by the roots of the trees in abstracting the food material from the soil. Thus, a soil that analyzes very rich in plant-food elements may hold them in such chemical combinations that the roots can obtain them only in minute quantities or not at all; while in a soil that appears poor in comparison when analyzed the plant-food elements may be in such chemical combinations that the roots can obtain them in the degree necessary for optimum results.

The real problem, then, is not whether this fertilizer, or that one, is good for peaches, but to determine whether nitrogen, potash (potassium), and phosphoric acid (phosphorus) are contained in the soil in sufficient abundance and in available forms for the needs of the trees.

The reader should here recall the very close bearing which tillage and the use of suitable cover- and green-manure crops have on the fertility of the soils, as presented in the preceding chapters. Not infrequently when an orchard has been neglected or improperly managed with respect to tillage and cover-crops and the trees are lacking in thrift and vigor with the attending signs of starvation, their condition is entirely and speedily changed for the better on the adoption of suitable methods of orchard management, the trees soon giving evidence that all needed plant-food is being supplied. The reader will recall in this connection the influence of the physical condition of the soil as affected by tillage and humus on the bacterial and other organisms in the soil and their relation to soil fertility.

It follows in logical sequence that questions relating to

the use of fertilizers call for settlement and definite action only after all the benefits of tillage and a liberal humus supply in the soil have been taken fully into account.

The very local nature of the fertilizer problem is thus declared. Hardly any two orchards are managed the same with respect to the soil; scarcely any two pieces of land have the same history with reference to the crops they have produced previous to their being used for orchard purposes. These factors and others have their influence on the plant-food content of the soil. It follows, therefore, that every orchard presents to the owner its individual fertilizer problems; and that when the needs of one orchard have been determined it signifies little or nothing with reference to another orchard, unless it happens that the soil conditions with reference to fertility are substantially the same in both orchards. It is entirely possible that a fertilizer which is the most economical to use in one orchard and which produces marked results will not be the most economical in another orchard, or, if applied, may even fail entirely to gain response of any kind.

The fertilizer problems in peach-growing are so local that they must be worked out on a rational economical basis, if at all, for each orchard; and where the soil in an orchard is not fairly uniform, different parts of the same orchard require different treatment with respect to fertilizers. It is only one step farther to say that the fertilizer needs of an orchard at any given period in its life may not be the same as they will be three or five or ten years later. It depends on the treatment the orchard receives meanwhile, together with the inherent characteristics of the soil. Moreover, there are no short-cut methods by which a peach-grower can find out whether his orchard needs fertilizers, and if

so what should be applied. His one recourse is to refer to the trees themselves, and the response they make to the application of different kinds of plant-food.

A soil must contain all the requisite plant-food elements in a form available to the tree, and in suitable amounts, if the tree is to thrive and develop normally. It has already been pointed out that in the practical consideration of the problems the peach-grower is concerned only with three elements, nitrogen, potassium, and phosphorus. These three elements are likely to be deficient for optimum results in the average soil, or if present they are in such chemical combinations that the tree roots cannot take them up. The economical aspects of the problem may now easily be seen. Not only may these three food elements be deficient, but any one or any two of them may be lacking while the others are present in abundance. Yet the absence of one may as effectively limit the growth of the trees and crop production as if all three elements were lacking.

A common practice among peach-growers, if they fertilize at all, is to apply a complete fertilizer, one containing in quantity all three of the plant-food elements mentioned above. If any one of them is deficient, it is thus supplied in the complete fertilizer, and naturally the trees respond in the manner desired. The grower is pleased with the results and thinks he knows the fertilizer needs of his orchard. Probably his neighbor peach-grower sees the results and applies the same kind of fertilizer to his trees. He may or may not secure the looked-for results. If he does it is an accident, not the reward of intelligent, well-directed effort on his part.

The fault with this procedure rests in the fact that a single plant-food only may be lacking and is thus the limiting

factor, while in the complete fertilizer all three of the elements are applied. If only one or perhaps two of them are lacking, to apply the one or ones already in the soil in abundance is without avail, and the pleasing results that may be observed came from the one element in the complete fertilizer that was lacking in the soil.

Thus, until a peach-grower has demonstrated by experiment that his orchard needs a complete fertilizer, it is decidedly unbusinesslike for him to apply it. It is likely to be wasteful and uneconomical. To apply in a fertilizer an element of plant-food which is already supplied abundantly in available form by the soil itself adds to the cost of production without any compensating returns.

Several experiment stations have conducted well-planned, comprehensive investigations with a view to throwing light on the plant-food requirements of peach trees. It is both impracticable and unnecessary to discuss here in any considerable detail the work done by the experiment stations along this line, but some of the results are especially illuminating and instructive. The more significant features, therefore, are briefly recounted.

Van Slyke[1] and his associates endeavored to determine as accurately as possible the amount of plant-food taken by peach and other fruit-trees of mature age in bearing during one growing season. The method of procedure was to collect separately all the leaves, fruit, and current season's growth made at the ends of the branches and make chemical analyses of them. One tree each of three varieties of peaches was used, an Elberta nine years old, a Champion, and a Chili (Hills' Chili) seven years old. The results of the analyses were presented separately for each variety and show con-

[1] N. Y. Agr. Expt. Sta. Bull. 265.

Plate XIII. — Pruning Elberta Peach Trees. *Top*, pruned to a low spreading head; *bottom*, a one-year-old tree cut back to a straight stem at *A* when planted, now in July of its first season's growth in the orchard.

siderable difference, due no doubt to differences in size of the crops on the different trees, size and vigor of growth, and the like. The figures herewith are based on Van Slyke's analyses, but are presented in the form of averages for the three varieties.

The accompanying table is largely self-explaining since the details are specific. It is to be noted that the largest item of weight is the fruit, that a relatively large quantity of potash is required, and that nearly all the lime is in the leaves, while the fruit makes large demands for all the elements reported except lime and magnesia, which are taken in relatively small amounts by the fruit.

TABLE IV. — AMOUNTS AND PROPORTION OF TOTALS OF PLANT-FOOD ELEMENTS IN THE ANNUAL GROWTH OF DIFFERENT PARTS OF A PEACH TREE AND ITS FRUIT BASED ON THE AVERAGE OF ONE TREE EACH OF THREE VARIETIES

PART OF TREE	WEIGHT OF EACH	WATER	DRY MATTER		NITROGEN		PHOSPHORIC ACID		POTASH		LIME		MAGNESIA	
			Weight	Proportion of Total	Weight	Proportion of Total	Weight	Proportion of Total	Weight	Proportion of Total	Weight	Proportion of Total	Weight	Proportion of Total
	lbs.	lbs.	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%	lbs.	%
Fruit Pulp	161.71	144.74	16.97	38.0	0.12	19.3	0.060	42.0	0.290	49.0	0.015	1.6	0.027	9.2
Stones .	9.96	3.33	6.63	14.5	0.03	4.0	0.008	5.0	0.007	1.0	0.003	0.3	0.007	2.4
Leaves .	45.75	29.56	16.18	35.5	0.42	67.7	0.070	44.0	0.270	45.0	0.778	82.7	0.237	80.9
New Wood	12.83	7.37	5.46	12.0	0.06	9.0	0.001	9.0	0.003	5.0	0.145	15.4	0.022	7.5
Totals	230.25	185.00	45.24	19.6	0.63		0.139		0.597		0.941		0.293	

Of course the total amount of plant-food taken by the trees is not represented in the table, since the increase in the size of the trunks, in the limbs more than one year old, and in the roots is not included in the analyses made. There is good reason for assuming, however, that the amount of plant-food entering into the growth of these parts of the tree is relatively small and would not very greatly affect the totals.

Therefore, since the above figures are not absolute in their accuracy, there is no violation of facts in discarding the small fractions in the table and presenting the substance in a more condensed form as follows:

TABLE V. — APPROXIMATE AMOUNTS OF PLANT-FOOD TAKEN ANNUALLY BY A MATURE PEACH TREE IN BEARING; ALSO BY AN ACRE OF TREES (108 TREES) AND THE RATIO OF THE DIFFERENT FOOD ELEMENTS

PLANT-FOOD	AMOUNT TAKEN BY ONE TREE	AMOUNT REQUIRED BY ONE ACRE (108 trees)	RATIO BASED ON ONE POUND OF NITROGEN
	lbs.	lbs.	
Nitrogen	0.63	68	1.00
Phosphoric Acid	.14	15	0.25
Potash	.60	65	1.00
Lime	.95	102	1.50
Magnesia	.30	32	0.50

In this table, which is based on Table IV, the demands made by peach trees on the soil fertility are suggested. Obviously these demands vary considerably from year to year as the crop varies. The last column in Table V shows the ratio in which different food materials are used. Thus, for every pound of nitrogen taken up by a tree there is

required $\frac{1}{4}$ pound of phosphoric acid, 1 of potash, $1\frac{1}{2}$ of lime, and $\frac{1}{2}$ pound of magnesia.

The work done by the New Jersey Station and reported by Warren [1] was along lines similar to that of the New York Station, but it was carried considerably farther in detail, the object being to determine the entire amount of plant-food removed by a tree in a ten-year period.

The tree used was a Late Crawford planted as a one-year-old in 1896. The plan required that the entire growth of leaves, the prunings, and the fruit after it began bearing be collected each year, weighed, and analyzed. After the tenth season, the tree was dug up with its root system as complete as possible, divided into parts, weighed and analyzed as for the annual growth products of the tree. The tree was separated into parts as follows: (1) The 1905 growth cut from the tips of all twigs; (2) the remaining twigs up to one inch in diameter; (3) remainder of the top to the surface of the ground; (4) roots larger than one inch in diameter; (5) roots smaller than one inch in diameter. A summary of the plant-food materials used during the entire ten years' growth is given in Table VI.

The data in the body of this table consist of the analyses that were made of the different parts of the tree. Therefore, they represent a very close approximation to accuracy in representing the amount of plant-food that was actually taken up by the tree and its products in ten years. The second section of the table shows the relative quantities of plant-food treating the nitrogen as unity. Thus in the total, it appears that for every pound of nitrogen used, nearly .3 (.27) of a pound of phosphoric acid and about .6 of potash were needed.

[1] An. Rept. N. J. Sta. for 1906, pp. 192–203.

Table VI. — Amounts of plant-food removed in ten years' growth in different parts of a peach tree

Portion of Tree	Weight	Amounts Removed			Relative Amounts Used in Different Parts		
		Nitrogen	Phosphoric Acid	Potash	Nitrogen	Phosphoric Acid	Potash
	lbs.	lbs.	lbs.	lbs.			
Wood and roots (when dug) .	275.0	0.629	0.217	0.328	1	0.34	0.52
Prunings for 10 years . . .	41.2	0.216	0.069	0.114	1	0.32	0.53
Leaves for 10 years . . .	170.5	1.775	0.351	0.991	1	0.20	0.56
Fruit produced	128.3	0.225	0.121	0.258	1	0.54	1.15
Total . .	615.0	2.845	0.758	1.691			
Estimated Total per acre trees 20 × 20 feet (108 trees)[1] . .		307	82	183	1	0.27	0.59

The yield of the tree used in this investigation for some reason was very small, only 128 pounds in all. The average yield for the orchard in which it stood was 277 pounds to the tree for the same period. As it began bearing the fourth year, the records cover in effect seven crop seasons, though one year it bore no fruit on account of frost injury. Had this tree produced crops that averaged as much as the entire orchard, and which was a very moderate yield, the amount

[1] In the report of this work by the New Jersey Experiment Station, all acre estimates are based on trees planted 15 by 16 feet apart or about 181 to the acre. As commercial orchards are now rarely planted as close as this, it seems better to reduce the acre estimates used here to the unit of 108 trees to the acre which results from planting 20 by 20 feet.

of plant-food removed, of course, would have been correspondingly more.

The estimated total amount of plant-food withdrawn by an acre of 108 trees is of course hypothetical. The number of trees to the acre varies considerably with different growers, and within certain limits probably the larger the number the greater the plant-food requirement. On the other hand, trees planted 16 by 16 feet would probably begin to crowd long before they were ten years old and they would, therefore, not be likely to be as large and vigorous as trees that had more space. Hence the plant-food requirements to the acre would cease early in the life of the orchard to be definitely proportionate to the number of trees where close planting and the consequent crowding occur, in comparison with a tree that grows without competition with others.

The estimated annual plant-food demands of the tree that was analyzed in the New Jersey work are illuminating and instructive as is also the length of the new twig growth in different years. In all these calculations the amount of plant-food in the tree when it was planted as a one-year-old is ignored, since it was so small as to be negligible.

The estimated annual demands during the ten-year period that enter into the consideration appear in Table VII, also the length of the new twig growth made each year.

It is to be noted that during the first four years, while the tree was making most of its growth, there was a gradual increase each year in the plant-food removed from the soil. The extremely small amounts of the different elements taken the first year is also of interest since it suggests that if the soil is in reasonably fertile condition when the trees are planted, there is little likelihood of their needing commercial plant-foods the first season. In the following six years

the amounts removed were quite uniform in the different years, the notable exceptions being in 1901 when for some reason there was nearly double the twig growth made in any other year, and in 1904 when there was no crop.

Table VII. — Estimated amounts of plant-food removed annually during ten years by the tree analyzed, the length of the annual twig growth, and the estimated plant-food demand per acre

Year	Number of Inches Growth	Estimated Amounts Removed by One Tree			Estimated Amount per Acre (108 Trees)		
		Nitrogen	Phosphoric Acid	Potash	Nitrogen	Phosphoric Acid	Potash
1896	541	0.026	0.006	0.011	2.8	0.2	1.3
1897	2388	0.102	0.027	0.059	11.0	2.9	6.4
1898	4723	0.233	0.050	0.131	25.1	5.4	14.2
1899	5818	0.364	0.082	0.200	39.2	8.9	21.6
1900	6757	0.369	0.100	0.201	39.8	10.8	21.7
1901	11716	0.535	0.146	0.311	57.8	15.8	33.6
1902	6502	0.365	0.107	0.219	39.4	11.6	23.7
1903	5284	0.299	0.087	0.181	32.3	9.5	19.5
1904	3469	0.263	0.064	0.168	28.4	6.9	18.2
1905	2729	0.289	0.092	0.211	31.2	10.0	22.8
Totals	44,927	2.845	0.761	1.692	307.0	82.0	183.0
Annual Average first 4 yrs.		0.181	0.041	0.100	19.5	4.4	10.9
Annual Average last 6 yrs.		0.353	0.099	0.199	38.1	10.8	23.2

There is of course no direct means of determining how much plant-food is required for the annual increase in size of the trunk and limbs two years and more old. It is doubtless relatively small, since the analyses made of the tree show that the new twig growth is very much richer in plant-food

elements than is the older wood. It was ascertained also that the amount of twig growth in any season was a fairly good index of the rate of growth of trunk and older limbs. The years in which the greatest twig growth occurred were also the years in which the annular rings in the trunk and limbs were the largest.

The results of these two investigations, one by the New York Experiment Station and the other by the New Jersey Station, tend to confirm each other in the main essentials. The New York analyses show a considerably larger relative use by the tree of potash, though both investigations emphasize the importance of that element, especially in the fruit, and they call particular attention to a surprisingly large requirement of nitrogen. The New Jersey results also bring to light the fact that in seasons when a crop of fruit was borne, the chemical composition of the ash of the leaves was much lower in phosphoric acid and potash than in years when there was no fruit, thus suggesting the transfer of these mineral plant-foods from the leaves to the fruit, a phenomenon more or less well recognized in other connections.

The results of an investigation carried on by the Arkansas Experiment Station and reported by Thompson [1] and which was prosecuted along lines similar to those followed in New Jersey corroborate in essential particulars the findings in that work.

It is well to point out here that, though these investigations and analyses show in some measure the plant-food requirements of peach trees and their products, they leave entirely unsolved the problem of how to meet those requirements.

[1] Ark. Expt. Sta. Bull. 123.

Other investigators have worked on the plant-food requirements from another standpoint — that of "questioning the soil," as it would be expressed by one of the earlier professors of agriculture. Application of different plant-foods and in varying combinations and amounts have been made for a series of years to selected blocks of trees in commercial orchards and the results of the different fertilizer treatments carefully recorded each season.

This type of experiment conducted in chert and shale soils in the Potomac Valley region of West Virginia has yielded well defined results, though not in all respects confirming preconceived ideas with reference to the use of fertilizers in peach orchards. In summarizing the results of this work, Alderman [1] comments in part as follows:

1. "At Sleepy Creek, West Virginia, an experiment with bearing trees has been in progress four years on a shale loam soil low in fertility, twenty trees of Carman and Waddell peaches constituting a plat.

2. "The yearly growth of the trees treated with nitrate of soda has been double that of plats receiving no nitrogen.

3. "At the end of the second year the bearing surface of the nitrogen fertilized trees was $2\frac{1}{2}$ times that of the non-nitrogen-fed block. At the end of the fourth year the difference was much greater.

4. "The leaves of the nitrogen blocks were healthier than the others, larger in size, about $2\frac{1}{2}$ times as numerous, and made up nearly four times greater area per tree.

5. "The nitrogen plats have set an average of 76 per cent fruit-buds each year against 60 per cent in the non-nitrogen plats.

[1] W. Va. Expt. Sta. Bull. 150.

6. "The yield of fruit was very nearly doubled by the use of nitrogen.

7. "Nitrogen delayed maturity several days.

8. "The fruit was not as highly colored in the nitrogen blocks as in the others. The high color of the non-nitrogen rows was not due to the influence of potash or any other fertilizer but rather to the extra sunshine that reached it through the sparse and sickly foliage.

9. "The difference in size of fruit was not great but nitrogen and potash in combination produced a slight increase.

10. "The average gross income per acre per year from all the nitrogen plats was $468.85 and from the non-nitrogen plats was $275.43.

11. "The influence of lime could not be definitely determined and must be regarded as largely negative although the production was somewhat increased.

12. "An experiment on young trees at Cherry Run on the same kind of soil was carried on in a similar manner to the Sleepy Creek test.

13. "No appreciable influence of any fertilizer could be detected the first year, due probably to the inability of the young trees to take up and assimilate large quantities of plant food.

14. "After the first year nitrogen produced a strong growth of wood and foliage, while potash apparently weakened the vigor of the tree.

15. "Only a small crop of fruit was produced the fourth year, but it was practically all from the nitrogen-fed trees.

16. "The theory that heavy fertilizing with nitrogen is injurious to the peach is shattered by these experiments, as is also the former conception of the value of potash."

Based on the general response of the trees to the different fertilizer applications under the conditions that existed in the orchards where these experiments were conducted in West Virginia, Alderman says:

"The commercial peach industry of West Virginia is at present confined almost wholly to a few counties in the Eastern Panhandle and, broadly speaking, includes only two general types of soil — shale and chert. In the writer's experience the chert lands when reasonably well cared for do not require artificial fertilization. They are, however, of comparatively recent development and in time may become exhausted to the point where feeding will be necessary. The shale lands upon which most of the commercial orchards stand present a serious problem. The writer is convinced that thousands of dollars have been thrown away by orchardists on that type of soil through misdirected applications of fertilizers running high in phosphoric acid and potash. From the result of our four years of experimentation and from reports from neighboring states we unhesitatingly recommend for bearing trees the application of 200 to 250 pounds of nitrate of soda (or equivalent amount of nitrogen in some readily available form) per acre for shale soil. For young trees we would suggest little or no fertilizer the first year, but after that one-half pound of nitrate of soda per tree until its fourth year, when the application may be doubled. We believe that the same treatment will be effective on other poor soils throughout the state, although this has not yet been definitely determined.

"The practical point at once arising is, can the expensive nitrogen be supplied as effectively and more cheaply by the use of leguminous cover-crops? It seems reasonable to believe this to be the case. Crimson clover, winter vetch,

cowpeas, soybeans, red clover, and other leguminous crops may be easily grown upon such soils, and all collect nitrogen from the air in considerable quantities."

From a comprehensively planned series of experiments in the same line on peaches at the Delaware Experiment Station, McCue[1] makes these deductions:

"Careful observations have been made of the effect of different fertilizing elements upon color. This work is as yet incomplete, but our tentative conclusion is that any effect of nitrogen, potash, or phosphoric acid upon color is secondary. The blocks heavily fertilized with nitrogen have been deficient in color, but this defect has been due to the profuse growth of foliage shutting off the light from the fruit. The potash blocks have had practically the same intensity of color as the check block. There is a suggestion that heavy applications of phosphoric acid may have a deadening effect upon color. These blocks while apparently having as much color as the potash or check blocks, have at the same time lacked in sprightliness of color. The color seemed to lack life and character. The effect is hard to describe in words, but I think that you will catch my meaning.

"In general the health of the trees is characterized by greenness and freshness of foliage. Plots that were treated with nitrogen or combinations of nitrogen and potash are characterized by their general thriftness. No diameter measurements have been made from year to year as it has been considered that a careful study of the annular rings after the trees have been cut down will give much more accurate data.

"The tests for keeping quality of the fruit from the

[1] Proc. of the Soc. for Hort. Science, 1914, pp. 88–89.

various plots are as yet incomplete, but such tests as have been made seem to indicate that potash has some beneficial effect in increasing the period of soundness of the fruit. However, this point needs further testing to confirm it.

"In time of ripening of the fruit we obtained striking results. Heavy phosphoric acid applications delayed ripening about two days and potash hastened it one day. Nitrogen either in combination or alone delayed ripening from a week to ten days. The power of nitrogen to retard ripening is much stronger than that of potash to hasten it, so that when nitrogen and potash are combined the hastening effects of potash are almost wholly overshadowed by the retarding effect of the nitrogen.

"So far as the effect of fertilizers on the time of blooming is concerned we have seen but little if any result. The total period of bloom is so short that the differences in blooming dates are minor ones and might be accounted for by other reasons. We suspect, however, that the effect upon the blooming period is similar to that upon the date of maturity, although the proof of it is not yet clear.

"We have no very clear and definite results upon the time of wood ripening in the fall for which the terminal bud formation has been used as a guide. It is generally supposed that heavy applications of nitrogenous fertilizers would make a soft immature wood, but our results, though inconclusive, would appear to refute this view. It is probable that the regulation of the soil moisture has a more intimate connection with fall ripening of wood and bud than does plant food."

On the basis of other fertilizer tests with peaches conducted with a view to determining the influence of mineral plant-

Plate XIV. — Pruning Elberta Peach Trees. *Top*, a tree in July of its second season in the orchard; *bottom*, the details of pruning during a series of years.

foods on the crushing and bending strength of peach wood, McCue [1] concludes as follows:

"A detailed study of the results of this experiment fails to throw very much light upon the influence of nitrogen, potash, and phosphoric acid in strengthening or weakening wood structures. The number of sticks tested was too small to make the results conclusive. Almost as much variation was found in strength of sticks from one block as in the averages for the different blocks. While in a general way the results are negative they seem to indicate that no great stress can be laid upon fertilizing for strength of wood. The fertilizer that is so balanced as to give the most healthy growth will produce the strongest wood. The writer believes that even greater differences in strength of wood in the peach can be obtained by different pruning methods than were obtained by different fertilizer treatments."

Some deductions made from fertilizer studies on peaches by the Missouri Experiment Station confirm in part the results of similar work elsewhere, but another element is introduced on account of the climatic factors that need to be considered in that part of the country. The following statements [2] are interesting and suggestive:

"Where nitrogen was applied to peach trees a good crop was produced and harvested. On plots receiving no fertilizer there was practically no crop. There was likewise a failure of peaches in the surrounding region where no fertilizer was applied. The cold winter of 1911–12 was disastrous to peach trees in Missouri. Injury to peach trees caused by the cold so weakened their vitality that disease

[1] Proc. of the Soc. for Hort. Science, 1915, p. 118.

[2] Mo. Expt. Sta. Bull. 111, pp. 247–248.

like the bacterial shot hole leaf disease was common. On the plots fertilized with nitrogen there was little bacterial disease. On adjacent unfertilized plots the injury from this cause was very great. The trees in the plots fertilized with nitrogen also recovered from winter injury much more successfully and quickly than unfertilized trees in the same locality.

"The application of phosphorus and potassium either singly or in combination did not result in increased yields. The results of the investigations on fertilizers for peaches seem to indicate clearly that a nitrogenous fertilizer or a method of cultivation and management which favors a vigorous tree growth when combined with pruning, spraying, and thinning fruit on overloaded trees will increase the crop. The above treatment tends to make them carry their fruit buds through winter and frosts of spring much more safely than where an average or weak growth only is secured. Our results seem to disprove the theory that trees must make their main growth early in the season and then be checked or retarded in their growth in August or September in order to ripen their wood before going into winter. In some experiments at this Station where the trees have been encouraged to grow vigorously right up until some of the green leaves froze on the trees, either by the use of fertilizer or by severely pruning back the winter before or by thinning the fruit, have uniformly carried their fruit buds through the winter much more safely than with trees that shed their leaves and ripened their wood early."

It should be noted that in Missouri and in some other peach regions the winters are naturally mild compared with the more northern latitudes. In northern latitudes the winter temperatures are fairly constant as a rule and low

enough so there is little danger of the buds swelling. It is essential in order to avoid winter-killing that the wood be thoroughly mature and well ripened on the approach of winter.

In many peach regions of which those in Missouri are representative, the winter temperatures are not constant but fluctuate from moderately cold to so warm that the peach buds are likely to start enough in midwinter to become tender. Even though the wood is not thoroughly mature when winter sets in, there is little danger that even the minimum temperatures will cause any serious winter-killing. There is constant danger, on the other hand, that warm periods will occur which will cause the buds to start, following which even perfectly seasonable winter temperatures may cause the destruction of the fruit-buds.

Whitten and his associates at the Missouri Station have shown that by keeping the trees in an active growing condition until practically the approach of winter, the buds do not start as readily during warm periods in midwinter as when they ripen at the period insisted on in the North and hence the danger of winter injury is greatly reduced.

As stated above in the quotation, the use of nitrogenous plant-foods offers one means of meeting the condition described. No very comprehensive summary of the plant-food requirements can be made from the foregoing presentation of the matter. The results, however, bring out rather clearly certain things:

1. The importance of liberal supplies of nitrogen. The results of experiments and the indications of the analyses made are habitually consistent in this respect. Where the fruit does not color as well when nitrogen is used, the

trouble is indirect and rests in the fact that the trees make a more thrifty growth of leaves, hence the fruit is more shaded than where these conditions do not obtain. By properly thinning the tops, this difficulty should be readily overcome.

2. The varying effects of the mineral fertilizers, phosphoric acid and potash.

3. The necessity of working out the fertilizer requirements in each individual orchard unless the different orchards in a community occupy sites the soils of which are uniform and similar and have had essentially the same history as to treatment, previous cropping, and the like.

It should be observed that in some cases the continued use of nitrogen has appeared to cause a reduction in the size of the fruit. The decrease, however, has not been important, since it did not impair the marketability of the fruit appreciably, and the quantity produced was increased in a marked degree.

It has been suggested that the reduction in size of the individual fruits as a result of the use of nitrogen is due to action of the foliage, which is usually very abundant where nitrogen is liberally applied, in withdrawing moisture from the fruit, or at least in taking up moisture which would otherwise go to the fruit. It is known that under some conditions, moisture may be transferred from the fruit to the leaves growing on the same branch.

The reader having an orchard fertilizer problem in hand who has reached this point now knows something of the nature of his problem, but is perhaps no nearer its solution than in the beginning. Only one course is open if the problem is to be solved in an economical and businesslike way. The experiments conducted by the different stations have

shown the method. In this they render every peach-grower a service, even though the results cannot be applied in detail to individual cases.

If a peach-grower is operating on a very small scale, he does not have a great deal at stake in his fertilizer bills and may be warranted in following whatever practice seems to give good results. But the extensive grower can hardly afford not to work out these problems in his own orchard, especially in case he is making a considerable expenditure annually for fertilizers. Otherwise, he may be buying and applying plant-foods for which he is getting no returns, or else by adding a small quantity of something he little suspects his trees need he may obtain beneficial results entirely out of proportion to the cost involved. But to ascertain just what plant-food or foods should be applied to his orchard, and in what quantity, in order to give him the best and at the same time the most economically produced crops, is the real problem. A simple set of experiments which any careful fruit-grower can carry out will supply more information than can be secured in any other way.

Such a set of experiments should be located in as representative a part of the orchard as can be selected and where the soil conditions are uniform. The plan should be to apply to selected representative trees in the section of the orchard where the work is to be located the different plant-foods both separately and in different combinations. The applications should be made in early spring about the time the trees are renewing their seasonal growth. The simplest arrangement which at the same time is comprehensive that can be suggested includes the following plant-food groups:

1.	Nitrate of soda	—	$1\frac{1}{2}$ lbs. to a tree.
2.	Acid phosphate	—	$2\frac{1}{2}$ lbs. to a tree.
3.	Muriate of potash	—	1 lb. to a tree.
4.	Nitrate of soda	—	$1\frac{1}{2}$ lbs. to a tree.
	Acid phosphate	—	$2\frac{1}{2}$ lbs. to a tree.
5.	Nitrate of soda	—	$1\frac{1}{2}$ lbs. to a tree.
	Muriate of potash	—	1 lb. to a tree.
6.	Check	—	no fertilizer.
7.	Acid phosphate	—	$2\frac{1}{2}$ lbs. to a tree.
	Muriate of potash	—	1 lb. to a tree.
8.	Nitrate of soda	—	$1\frac{1}{2}$ lbs. to a tree.
	Acid phosphate	—	$2\frac{1}{2}$ lbs. to a tree.
	Muriate of potash	—	1 lb. to a tree.
9.	Check	—	no fertilizer.
10.	Lime	—	10 lbs. to a tree.

With these combinations of plant-foods it is possible for a grower to observe the response of his trees to any one element used alone, to any two used together, and to all three combined thus making a complete fertilizer. It is not essential to include lime in the experiment but it is well to do so. If some of the plant-food combinations are also used in conjunction with lime it will add to the completeness of the experiment, as will the use of stable manure on one group of trees, for comparison with the commercial plant-foods. Furthermore, it may be of very material advantage to add still one more group which shall be the same combinations as No. 8 but with a considerable increase in the quantity of the materials used, perhaps even doubling them. The other groups would indicate strongly what plant-food or combination of foods was needed, while this additional group similar to No. 8 except in quantity would help the grower to decide how much of the different elements should be applied.

The laying out of the different plats to receive the several combinations needs to be done with care. The smallest number of trees in each plat that can be considered satisfactory is two; more would be better. There should be at least one tree in every direction between the different fertilizer plats which is not included in the experiment; otherwise, should two plats that receive different combinations be located side by side with no intervening trees to separate them, the effects of the plant-foods would be likely to overlap and the results would be confused.

Each plat should receive the same plant-food combination every year as long as the work is continued. The number of years it should be repeated is indefinite. Obviously the real measure of the effects of the different plant-foods is the fruit produced and the strength and vigor of the tree. However, if the work is begun in the second year after the orchard is planted, some strong indications of what each combination is effecting might be obtained by the time the orchard has produced its second or third crop.

The interpretation of the results should not be difficult. The condition of the trees in the different plats should be compared, the fruit from each one measured or weighed separately, and the results recorded for subsequent reference. The appearance, size, and color of the fruit from the different plats should also be compared.

Of course any difference in the first three plats which receive respectively nitrogen and phosphate and muriate of potash will be directly traceable to the plant-food applied in each case. Should the results of No. 4 be like No. 1, it would be clear that the potash in No. 4 was giving no returns for its use; and if No. 7, for instance, which has acid phosphate and muriate of potash, gave no better returns

than the check plats, it would still further confirm the value of nitrogen under the particular conditions of the experiment. In the same manner the deductions may be made for all the plats and by the process of elimination the plat and plant-food combinations which gave the best returns can be located, and on these results the future applications of fertilizers can be based.

The inevitable question of whether it pays will arise. The owner of the orchard must answer for himself. If a fertilizer produces increased returns sufficient more than to pay the costs of material and labor, it may be regarded as a profitable procedure. If increasing the quantity applied brings returns in proportion to the increased cost, or better, it would appear to be a money-making proposition to apply the larger amount of plant-food.

Finally, there remains for mention some of the newer views in regard to soil fertility factors, for which there seems to be good support, and which have not previously been taken into account. They must still be largely ignored so far as peaches are concerned for lack of information. The roots of plants may give rise to, or secrete, substances — complicated chemical compounds — which are toxic or poisonous to the roots themselves. Thus when in the past a farmer has spoken of a piece of land as being "clover sick" or "wheat sick" there may have been more in the expression than he realized. That the roots of peach trees ever develop substances in the soil which are toxic to themselves is an entirely unknown possibility. There are occasional instances, however, when the soil is known to be fertile but for some obscure reason the trees do not thrive. A peach-grower rarely thinks it advisable to replant an orchard site to new trees immediately on taking out an old

orchard. Doubtless experience has taught that the new trees when so planted are likely not to thrive. That a peach tree "runs its span of life" in twenty years or less, while an apple tree may be at its best when 50 to 75 years of age, may have no bearing on the point in question. Yet these are facts, largely unexplained, with which fruit-growers are conversant. At the present time, the suggestion is purely speculative that these phenomena may ultimately find their explanation through the agency of this rather newly applied soil fertility factor, but at least the field for investigation is open.

CHAPTER X

PRUNING PEACH TREES

There is probably no other operation in the production of fruit concerning which such wide differences of opinion and practice prevail as in the pruning of trees. The fact that trees may produce abundantly under practically all systems of pruning or with no pruning whatever forces the conclusion that the operation is one to which dogmatic rule-of-thumb directions cannot be safely applied. However, as a general proposition, the most successful fruit-growers habitually prune their trees, and in doing so they usually follow more or less closely some plan or system, even though they have no clear-cut conception of just what their plan involves.

Before an architect begins to draw the plans for a building he must have a mental picture of the completed structure, at least so far as the main features are concerned. He must know what details are necessary at every step, as he develops the plans, in order to produce the desired results. Similarly, the man who prunes a fruit-tree during its first years must have a clear conception of what the tree is to look like when it reaches maturity, and he needs to know from the beginning what is necessary each time it is pruned in order to develop the tree which forms his mental vision. Of course such a picture can develop fully only with experience and as one

becomes familiar with the characteristics of growth, habit, and behavior of the different varieties. At the same time a well-formulated plan, based on a knowledge of the underlying principles of pruning, is essential if the operation is to be anything more than a haphazard removal of branches that appear to be in the way. No two trees are alike, however, hence each one presents its own individual problems in pruning, even though the grower may have a good knowledge of the principles involved.

In discussing the pruning of peach trees, it will assist the reader materially to have in mind rather clearly the various objects that may be accomplished by this operation. Unless one knows why he prunes and what is to be gained thereby, he is not likely to do it very intelligently. The principal objects may be enumerated, without reference to relative importance, as follows:

1. To modify the vigor of the tree.
2. To keep the tree shapely and within bounds.
3. To make the tree more stocky, thereby increasing its mechanical strength.
4. To open the tree top to admit air and sunshine.
5. To reduce the struggle for existence in the tree top.
6. To remove dead or interfering branches.
7. To aid in stimulating the development of fruit-buds.
8. To secure a uniform distribution of fruit-bearing wood.
9. To thin the fruit.
10. To enable the fruit to ripen more uniformly.
11. To make thorough spraying possible.
12. To facilitate the harvesting of the fruit.
13. To regulate wood growth, in some cases, with reference to winter injury.
14. To aid the tree, in some cases, in overcoming winter injury.

It will of course be observed that some of the objects as stated are more or less incompatible with one another. There is no contradiction, however, since it is not implied that the attendant needs all exist in the same tree at the same time.

WHEN TO PRUNE

To attain most of the objects of pruning, it should be done annually and during the dormant period, preferably in late winter or early spring, just before growth starts, unless in some regions it is found that bleeding from the wounds is likely to occur. In such regions it should probably be done in early winter. But conditions must be considered in each case. If the pruning operations are very extensive, economic requirements may make it necessary to prune throughout the winter whenever the weather is suitable for men to work in the orchard. If the fruit-buds are endangered during the winter by adverse temperatures, it may be advisable to delay pruning as much as labor and other conditions permit until settled spring weather arrives. This is especially advisable if heavy heading back of the previous season's growth is considered, since if a large proportion of the fruit-buds have been killed, the terminal growth still bearing living buds, and which under normal conditions would be cut away, should be left on the tree.

A limited amount of summer pruning can also be done to advantage under some conditions.

SOME GENERAL PRINCIPLES OF PRUNING

It is a generally recognized principle in all pruning that a heavy reduction of the top of a tree when dormant, as in

severe cutting back of the branches, tends to stimulate wood growth. It follows, therefore, that the best results can be secured only when the person doing the work takes into account the growth characteristics of the variety, or of the individual tree. A strong, vigorous-growing tree ordinarily should not be pruned as severely, so far as the control of the growth is concerned, as a weak-growing tree. Heavy pruning of the latter type of tree tends to induce a more vigorous growth of branches.

In the making of wounds in pruning, as in removing limbs, great care should be exercised that no stubs are left. Where a smaller branch is removed from a larger, the cut should be made as close to the larger one as possible and parallel with it, rather than at right angles to the limb severed. The latter results in a smaller wound but it leaves a short stub on one side of the wound that will not heal as readily as will the larger wound when made as stated above. In heading back limbs into wood more than a year old, they should be cut back to a side branch. Otherwise, if severed at a point between side branches, a stub remains which would never heal over, but it would die back to the next side branch and eventually decay.

Wounds so large that they will not heal over in one season may well be covered with a good white lead paint to protect them against weather-cracking and the entrance of moisture. But when an orchard is regularly and properly pruned, few large wounds that require painting will be made.

Obviously the pruning which a tree receives during the first two or three years after it is planted greatly influences its future. Mistakes in forming the head or the results of neglect during the early years in the life of a tree are practically irreparable. On the other hand, if a tree is well

formed and properly pruned during its first years, the foundation for a good tree is established; subsequent errors in pruning, if they occur, may admit of correction perhaps without permanent harm to the tree.

While the details of pruning vary greatly as practiced by different growers, a single system, as far as the general shape of the tree is concerned, is almost universal. Nearly all growers prune more or less definitely to a "vase form," the name being vaguely suggestive of the somewhat vase-shaped outline made by the top of the tree. Rarely one hears mention of a peach tree pruned to a "central leader," but this system of pruning is so seldom used in peach orchards that it calls for no further comment. The "vase form" implies in a general way a tree with an open center.

PRUNING TOOLS

It is unnecessary to discuss at any considerable length, tools for use in pruning peach trees. Where the work is done systematically and timely, there will rarely be occasion to remove a limb that cannot be severed with a strong pair of hand pruning shears. In fact, practically all the work can be done with this type of implement. However, a saw is necessary at times, one of the narrow bladed patterns especially intended for pruning purposes being convenient. Some use a long-handled pruning shear with staff six or eight feet in length for reaching the ends of the branches of tall trees when heading them back. However, if there is much of this type of work to be done, it will be better usually to supply a step-ladder from which the operator can reach the branches with his hand shears. Sometimes a pair of heavy lopping shears with handles about three feet long is very

PLATE XV. — POSITION OF FRUIT-BUDS OF DIFFERENT VARIETIES. *Top*, buds in singles — Chili (*Hills' Chili*) variety; *bottom*, buds in pairs — Waldo (left) and Angel (right).

useful, especially when there are many large limbs to be removed.

PRUNING THE FIRST YEAR

The pruning of a peach tree at the time of planting has already been discussed. A tree in July of its first season's growth in the orchard is shown in Plate XIII. When planted the tree was cut back to the point marked *A*, making a straight unbranched stem 16 or 18 inches high. It will be observed that the top in this case is formed of four main branches, thus making a symmetrical, nearly ideal tree. Some growers of large experience consider three branches ample for forming the permanent top and much prefer that number to more. The four branches shown in Plate XIII each developed from a bud that was on the trunk when it was planted. The growth now in evidence was all made the first season, after planting and prior to the last of July. Considerable more growth was doubtless made before the end of the season. It will be observed that the limbs are already branching to some extent.

However, the exact number of branches which may be used in forming the head is not arbitrary. From three to five on the smaller growing sorts are permissible, if they are well placed and properly distributed on the main stem of the tree. The branches that form the head of the tree shown in Plate XIII (*bottom*) start from points fairly well distributed along the trunk, but if there was more space vertically, that is up and down the trunk, between the branches where they join the trunk, there would be less danger of their breaking down in later years from the weight of heavy loads of fruit.

A tree that has been started and formed in a manner similar

to the one shown in Plate XIII will not usually require much attention so far as pruning is concerned during its first season in the orchard. Perhaps a little pinching back of the three or four main limbs as may be done with the fingers and without the use of pruning shears would help to make them more stocky. Such pinching back, however, should be done with discretion and in most cases it may well be confined to such limbs as are making the tree unsymmetrical by growing faster than the others. This type of pruning should not be done much after July 1; in the North perhaps the middle of June is as late as it would be safe, since the side shoots, the development of which it is likely to induce, should have ample time to ripen well before the arrival of cold weather.

Fig. 10. — A peach tree in July of its first season's growth in a southern orchard.

When a tree develops such heavy dense growth during the first season following planting as is shown in Fig. 10, a moderate amount of summer pruning may be important. This is the case especially in the peach regions where the growing season is very long, as in the South. The tree shown in Fig. 10 is one planted early in the spring in a southern orchard. The figure shows the tree as it looked early in the following July. Pinching back the ends of the main limbs will help to keep the tree symmetrical and it will also avoid the neces-

sity of heavy pruning during the dormant season, as might otherwise be necessary. Frequently a tree will send up sprouts from buds along the trunk and below where it is desired the permanent head shall be formed. It is best to remove these branches as soon as they appear. As a rule, however, not very much thinning of the branches should be done the first season unless the top is becoming extremely dense, since it will tend to weaken the tree. For example, Fig. 11 shows the tree in Fig. 10 as it appeared after it was summer pruned on July 8. (It was planted the previous spring.) It may be doubted whether the tree was not seriously checked by such heavy pruning in midseason. The pinching back of the leading branches and the removal of any superfluous limbs which were obviously crowding and interfering with the development of permanent limbs should usually be the extent of summer pruning the first season.

FIG. 11. — The tree in Fig. 10 after being heavily pruned in midsummer.

While the pruning done in the summer is aimed in part toward shaping the permanent top of the tree, that which is done during the first dormant period, that is, after the tree has made one season's growth in the orchard, is perhaps the most important in the life of the tree so far as the formation of the top is concerned. A tree at the time it is planted is pruned either to a straight stem, or short stubs of side

branches are left as described on page 90. The top at the next winter pruning consists, therefore, of whatever growth has developed during the growing period save such as may have been removed in summer pruning.

The limbs that are to make the permanent top must, therefore, now be selected. Three or four limbs well placed on the stem and of uniform size, thus making a well-balanced top, should be selected from those that have developed. If it is assumed that the four limbs which make the top of the tree in Plate XIII continued to be as symmetrical throughout the season as shown in the figure, they would be nearly ideal for the making of the permanent frame of the top. The tree in Fig. 10 also possesses the foundation of a good top, as may be seen in Fig. 11, but as previously stated the tree would probably have been better ultimately if the final shaping had been delayed until it was dormant.

Having decided on the branches that are to form the permanent top, all others should be removed. If the frame branches have developed so many side branches that they are likely to fill up the center and make it too dense, some of them should be removed. From the very beginning, the top should be so pruned that it is kept open to sunlight and air. At this time, too, the main branches, and perhaps also the stronger growing side limbs, should usually be headed back somewhat. This will tend to make them stocky. How much they should be headed back is an open question. The rule commonly given where the growth has been fairly strong is to cut back the main limbs from one-half to two-thirds of their length, that is of the previous season's growth. The question is, however, whether anything is to be gained by such heavy cutting back. There is a conviction on the part of many with wide experience that the common practice has been extreme,

and that better results are ultimately secured if the heading back at this first dormant pruning is not more than eight inches to a foot even where the growth is fairly vigorous. Some heading back is necessary, however, else the stocky symmetrical growth desired will not be secured.

PRUNING THE SECOND YEAR

The tree starts its second season's growth well established in the orchard. The branches left on the tree when pruned during its preceding dormant period, with their attendant buds, furnish the potential possibilities of a large growth and the development of many branches the second season. Every bud is a potential branch. Usually it is only the buds towards the outer extremities of the limbs that actually develop secondary branches of importance in the future of the tree. It is because of this characteristic in the development of the secondary branches that heading back becomes such an essential operation in making a tree stocky and mechanically strong.

Because of the large number of side or secondary branches that will develop the second season and the crowding in the top which results therefrom, more summer pruning can be done the second year than was advisable the first summer when the tree was just getting firmly established after transplanting to its permanent location. Not much heading back should be done, however, after the last of June. If thinning out of superfluous growth seems advisable to admit sunlight and air, it may receive attention somewhat later in the season than is advisable for the heading back.

It is in the second season usually that the growth characteristics, if there be any, of different varieties become pro-

nounced. Plate XIV (*top*) shows an Elberta tree in its second season in the orchard. The rather open spreading habit of growth is well defined. Probably but little heading back of the main limbs was done the winter before since they are rather slender, yet they are branching well. As the top is made up of only four scaffold or frame limbs, and these are spreading well, the top has not thus far become excessively dense. Some pinching back of a portion of the terminal growths should be done to keep the tree symmetrical, following which a little later some thinning out of side branches may be necessary. Pinching back would tend to induce a stronger growth of the side branches. The flat-topped, rather open-growing varieties like Greensboro, Waddell, and Smock will not be as likely to need summer pruning as some of the more upright dense-growing sorts like Stump, Late Crawford, and others.

The dormant pruning following the second season's growth will not differ in kind from that which was done the winter preceding. Enough thinning out of the side branches should be done to open the top well and such heading back of the growth made the previous summer as is necessary to keep the tree within bounds and to prevent the main limbs from becoming "leggy" and getting out of reach. Perhaps a larger proportion of the new growth will need to be cut off in heading back at this time than was done the year before. However, discretion which is largely the outgrowth of experience, is necessary in the heading back at this time. If too severe, it will tend to retard bearing. If not heavy enough, the branches will soon become too long as above stated. The wise balancing of the two aims is the test of the pruner's skill.

In pruning at this time also, that is the dormant pruning after the second season's growth, care needs to be exercised

in directing the form of the top, even more than at the first dormant pruning. In case of a tree that tends to grow very upright, the cuts made in heading back should be at such points that the topmost bud on each limb is on the outer side. In the same way, in heading back a tree that naturally spreads too much, the limbs should be cut off in heading back where the topmost bud will be on the inside. The resulting tendencies of a tree with regard to the spread of the top can be very materially influenced in this way, since usually the branch which develops from the topmost bud is the strongest and virtually takes the place of the "leader" that has been cut off.

PRUNING THE THIRD AND SUBSEQUENT YEARS

Pruning following the third season's growth does not differ greatly from that of a year previous. However, the tree may have borne a little fruit the third year. If the conditions are favorable, it ought to bear a paying crop the fourth season. Up to this time the pruning has been directed especially toward the growing of a strong stocky tree that would sustain the weight of a large crop of fruit. If this has been well done, the pruning from now on will be directed more to fruit production. One of the governing facts which is of fundamental importance is that the peach always produces fruit on wood of the previous season's growth and the fruit-buds form also in the previous season. It, therefore, follows that removing a portion of the growth made the season before has the effect of thinning the crop. While some heading back will be necessary nearly every year, it should be done largely with a view to the prospective crop.

For this reason orchardists sometimes delay pruning as late in the spring as possible, especially if there have been

frosts or freezes that have endangered the fruit-buds. If the buds prove to be uninjured, a considerable reduction of the previous season's growth may be desirable as the cheapest way of partially reducing the prospective excessively large crop to the amount which the tree can successfully carry. On the other hand if the buds have suffered heavily from adverse temperatures, it may be unwise to reduce the number at all by heading back or otherwise decreasing the previous season's growth of wood. The same may be true though for a different cause, if for any reason, such as a severe drought, the tree made very little growth of new wood the season before.

Still another feature enters into the problem of heading back. This is the position of the fruit-buds on the new growth. In some varieties or under some conditions, most of the fruit-buds form near the base of the twigs; in others, towards the terminal ends; while in still others, the buds are uniformly distributed the entire length of the twigs. Moreover, some varieties under certain conditions develop many short spur-like twigs along the main branches and larger limbs which are little less than fruit spurs and on which much fruit is commonly borne. The manner in which the trees are pruned influences materially the formation of these spur-like twigs. Again, fruit-buds may be borne in pairs, one on either side of a leaf-bud or singly. These two formations are shown in Plate XV. The position of the fruit-buds in relation to the leaf-buds is shown in Plate XVI. Without further elaboration of details, it will be apparent that these various positions occupied by fruit-buds in some varieties or under certain conditions must be fully taken into account in heading back the trees, else the results are likely to be very different from what the pruner expects.

It may be difficult or even impossible in all cases to distinguish positively between fruit- and leaf-buds by the means ordinarily at the disposal of a fruit-grower when they are in a perfectly dormant condition, but in general, a fruit-bud is larger, plumper, and the point more rounded than a leaf-bud, but this distinction does not always exist in an appreciable degree. The peach-grower will do well to study carefully the characteristics of his different varieties in these respects, and with regard to the position of the blossoms, while the buds are opening and when the trees are in bloom. When the fruit-buds reach the condition shown in Plate XVI or even considerably before this stage, they are readily distinguished from the leaf-buds.

After bearing age is reached, even more careful attention should be given to keeping the top well thinned out than during the early years of the orchard. If the top is allowed to become too dense, the struggle for existence among the branches will result in their becoming weak and many of them may die. It is only by keeping the top open to the sunlight and air that the interior growth will be strong and develop an abundance of well-matured and vigorous fruit-buds. Keeping the top well thinned out so that every fruit gets its full complement of sunshine results also in well-developed, highly colored fruit. Only by this practice can fruit of the best color be expected from the interior of the tree. Again, an open top is essential to thorough spraying. Otherwise, it is impossible, without much loss of time, to spray effectively. For these and other reasons, the keeping of the top well opened by pruning has much to do in the development of high-grade fruit.

In this general consideration of pruning peach trees, the details of the operation recorded in the tree shown in Plate

XIV (*bottom*) are instructive. When planted, this tree was headed back to the point where the branching begins at *A*. The branch *AB* grew the first season, *B* being the point at which it was headed back following the first year's growth in the orchard. From two buds near the outer end of the branch *AB*, there grew during the second season the limbs branching from *B*, one of which was headed back at *C* during the second winter. The bud at the end of the branch at *C* which developed a "leader" the third season was on the side of the branch at the left as one views the picture, and as the leader grew it made an angle to the left with the limb *BC*, and during the third season the branches 3 and 4 grew, the latter being rather weak and small. The third winter branch 3 was cut back at *D*. Again one of the buds near the end of the branch at *D* was on the left side and when from it branch 5 grew, it, in turn, made an angle to the left with the limb *CD*. Branches 6 and 7 also developed from buds near the end of the limb at *D*. The same conditions again appear at *E*. Thus the general direction of the limb from *A* to *E* made up of sections *BC*, 3 and 5 was determined by the position of the buds near the outer end of each section, which, in its turn, developed a "leader" branch. The same may be traced in other limbs in this tree. Had all the branches been cut back each season at points corresponding to *B*, *C*, *D*, and *E*, so that the topmost buds were on the outside of the limb, it is obvious that the general effect would have been very definitely to increase the spread of the top. This would have tended to produce a tree similar in form to the Elberta shown in Plate XIII (*top*). The center has been cut out while the side branches have been induced to grow nearly horizontal, thus making a tree that is easy to pick, spray, and otherwise manage.

While, perhaps, in pruning the tree shown in Plate XIV (*bottom*) not enough attention has been given to developing a large bearing surface throughout the top, it does show, on the other hand, an exceptionally good skeleton plan of forming a desirable top.

The preceding discussion of pruning has been directed toward the development of a "vase form" tree. Another method of pruning to a vase form used in California to some extent and locally called the "Sims' method," after the one who originated it, is described as follows:[1]

"The trees are cut back to eighteen inches at planting, and at the first winter's pruning four or five of the most upright growing branches are left to form the head. These are cut to a uniform height and as great a length as the season's growth will allow. On a vigorous tree this will be about six feet. All laterals are removed from these.

"The second winter retain one strong upright branch emerging from near the end of each branch of previous season's growth, and remove all laterals from the tree larger than a lead pencil. Top these main branches at a uniform height of ten or twelve feet from the ground according to the growth made. Sometimes a lateral is allowed to grow from one of these main limbs to fill in an open space in the outline of the tree. At the end of the second winter's pruning we have a low-headed tree with four or five main branches ten or twelve feet long and so upright that the tree is only six or seven feet across the top. Enough small laterals are left for abundant shade. After this each season remove all large laterals leaving only the small fruiting wood and cut this back to the required amount."

[1] Monthly Bull. Calif. State Com. of Hort., Vol. III, No. 3, March, 1914, pp. 146–147.

Some of the claims for this method are that no propping is necessary, it is easy to work close to the trees with tillage implements because of the upright positions of the limbs, and the trees are more easily kept within manageable limits than by other methods. It is said to work well with very strong growing varieties especially where conditions are favorable for especially vigorous growth, but it is doubted whether it would be satisfactory where the growth is not particularly vigorous and where it would require perhaps three or four years for the main limbs to reach the desired height. It is not known that this method is used except in certain localities in California, but it is possible that with some modifications to meet conditions of tree growth it might find application elsewhere.

A general plan of pruning worked out by S. H. Fulton of West Virginia on the basis of wide experience in that state and in Michigan consists in forming the head rather arbitrarily, when possible to do so, of three framework branches, these being selected when the trees are pruned following the first season's growth. At that time these three branches are headed back somewhat heavily. The next year but two side branches are allowed to remain, as a rule, on each of these main limbs, and these in turn are headed back. Other details are described by Fulton as follows:

"Briefly, our plan of pruning peach trees hinges on the development of low open centered trees with only three main branches. We prune rather severely the first three years aiming to develop a short-jointed stocky framework, uniformly and not too closely distributed around the open center. In this pruning only a limited number of the strongest and best placed terminal growths are allowed to remain for framework branches.

"After the trees are in bearing we do no very heavy cutting for the next few years except to remove branches that cross or interfere. Terminal growths more than twelve to sixteen inches in length are thinned out and those allowed to remain are cut back from one-third to one-half.

"After our trees have borne several crops and begin to lose vigor making only a short annual growth with a diminishing number of fruit-buds we intensify our pruning, cutting back into two-, three- and sometimes even four-year-old wood. We are careful to cut back to a good lateral branch in each instance so that the wounds will heal over readily and no stubs will be left to induce decay. Framework branches are interfered with as little as possible. If the tree has grown too tall as is apt to be the case with tall growing varieties like Reeves, we do not hesitate to cut back tall center branches sufficiently to bring the tree within bounds for convenience in spraying and harvesting the fruit. As peach-growers well know, heavy pruning renews the vigor of the tree and increases the size of the fruit. In doing this heavy pruning we avoid cutting away too much of the top in any one season as this results in a rank growth of new wood and practically no fruit the following year. As peach trees age we find they are able to carry less fruiting wood unless they are on strong land or are kept well supplied with nitrogenous fertilizers. Even under the latter conditions it pays to reduce the tops of old trees, as the quality of the fruit will thereby be improved.

"In our experience, very severe pruning commonly called 'dehorning' is apt to be followed by bad results and accomplishes no purpose that cannot be better accomplished by the more moderate method described above. Dehorning largely destroys the framework of the tree and leaves ugly

stubs which invite decay, thus shortening the life of the tree. Furthermore this radical type of pruning may kill the tree outright especially if the pruning follows winter injury. Many of the trees which do survive start off stronger from one point than another and do not develop well-balanced tops. The rank growth following bears few fruit-buds and a year's fruiting is lost. These observations are based on the experience of the writer in Michigan following the severe winter of 1898–1899 and in West Virginia following the February freeze of 1912. In both instances we made pruning tests and the trees pruned moderately gave better results subsequently, both in point of tree growth and fruitage than unpruned trees and very decidedly better results than dehorned trees. In fact about 25 per cent of the dehorned trees died the following season in each instance.

"In recent years we have tried to hit on a plan of pruning old peach trees which will make heavy cutting unnecessary, the idea being that if just the right amount of wood is taken off each season the vigor of the tree and size of fruit will be kept up year after year within reasonable limits and severe pruning will not be necessary. In following out this idea we have thinned out the current year's growth thoroughly and headed in the remaining twigs closely. We have also given special attention to preserving and encouraging the development of fruiting wood low down on the framework of the tree to offset the tendency of an old peach tree to produce practically all its fruit on the terminals of long pole-like branches. We have made some progress with this plan but have not been able to do away with moderately heavy pruning entirely. I believe, however, this would be a safe ideal toward which to work and coupled with proper applica-

Plate XVI. — Fruit-buds of peach starting into growth, with leaf-buds at base of the fruit-buds also beginning to grow.

tions of nitrogenous fertilizers it is possible the idea might be carried out to a successful conclusion.

"For the past six years we have been testing out the plan of rejuvenating peach trees by cutting back moderately heavy a section of the top each year over a period of about four years. The first year about one-fourth of the top is treated, the next year another fourth, and so on, until the whole top is pruned. The pruning is not done over the entire top each season but is restricted each time to a limited section of the top. The first year there is very little growth from the treated section, but the next year after another section has been pruned, the quarter first pruned makes a good growth and sets an abundance of fruit-buds. This method does not cause the loss of a crop at any time while the treatment is in progress as is the case when the dehorning treatment is used. However we have not found this system so satisfactory as that of giving the entire top a moderately heavy pruning all at one operation when it becomes apparent that the trees are losing vigor."

In the pruning of trees with the various objects in mind that have been enumerated, it is often as important to know what not to do as what to do. The following illustrations teach some important practical lessons in pruning peach trees.

In Plate XVII (*top*) is shown an extreme type of poor pruning yet one that is not very uncommon. The outer portion of the tree has not been well thinned out, and the smaller, secondary growth has been entirely pruned off from a considerable portion of each of the main limbs instead of being utilized to develop fruit-bearing branches in the center, where its weight can best be supported without breaking the tree. With the bearing wood largely developed toward the outer

extremities of the branches and the size of the branches disproportionately small for their length on account of not having been properly headed in, even a small crop of fruit would be likely to break the tree to pieces very badly.

This type of tree may be contrasted with the one presented in Plate XVII (*bottom*) which shows a tree that is stocky and the main limbs completely covered with fruit-bearing wood. Though the top of this tree is very open, the growth is so developed that there is no danger of the limbs being injured by sun-scald. There may be some varietal differences in the habit of growth between the two trees shown in Plate XVII, but from the standpoint of the features in question such differences are doubtless unimportant if they exist.

An entirely different type of tree is shown in Plate XVIII (*bottom*). The trees now nine years old were headed very low and evidently the tops were formed rather systematically of three or four main branches, but there is no indication of their ever having been headed back either when they were young or later. As a result, the natural tendency for a limb to elongate each year from the outermost bud has been fully exercised. The outer bud in the case of these trees has habitually been the terminal bud. The development of side branches has not been stimulated as would have been the case had the limbs been wisely headed back. The result is an orchard in which the trees are difficult to spray, the bearing surface nearly all so high that little of the fruit can be picked without the use of a step-ladder, the limbs cannot sustain a heavy load of fruit and in various other ways due to poor pruning or none at all, the trees are in poor condition.

In Plate XVIII (*top*) are shown two Elberta trees fourteen years old which are exceptional for their size, the

spread of the limbs of the two trees being fifty-five feet. They possess remarkable bearing surface and present a striking example of what can be accomplished by systematic, wisely directed pruning in developing a peach tree.

Still another form of Elberta tree appears in Plate XIX. It is not as old by three years as the trees in Plate XVIII (*top*), but it has had good attention though controlled by somewhat different ideals. The top is well opened, it has large bearing surface, and is in condition to produce a large quantity of highly colored fruit, but it will be borne mostly towards the extremities of the limbs where much of the picking will probably be done from step-ladders.

The trees in Plate XIX (*top*) were not formed with great care nor with regard to any very definite system during their early years in the orchard. They have been pruned regularly, headed back with discretion, and have developed a large bearing surface since the wood of the previous season's growth is well distributed and abundant. They have been pruned regularly with a view to securing the most practical ends but without special concern for the best possible appearance of the trees.

The type of orchard step-ladder or stool here shown (Plate XIX) is an excellent one for use in an orchard located on a steep slope. The legs on one side are commonly made somewhat shorter than on the other to conform to the slope of the land, while the top has sufficient surface to give one a sense of security when standing on it.

In Plate XX (*bottom*) is shown still another ideal. It is a Phillips tree grown on fertile soil under irrigation. These factors of environment account for the large size and dense foliage. The tops are probably too dense but this variety is one of the leading sorts grown in California for canning.

Large size of fruit and productiveness of tree are, therefore, probably more important than high color, hence the density of the top and certain other characteristics of the tree and its environment are correlated to some extent with the purpose for which the fruit is used.

While it may be necessary or advisable, when trees are very heavily loaded with fruit, to prop the limbs as shown in Plate XX, to prevent them from breaking, the form of support shown in Fig. 12 can be used in many cases to good advantage. Large screw-eyes are screwed into the limbs which soon rust enough to prevent them from pulling out with any ordinary weight of fruit. Then wires, one end of each being twisted into a screw-eye, pass to a common center which is a small ring. In this way each limb is supported by all the others on the opposite side of the tree. This plan of giving support to the limbs does away with the inconvenience of the props.

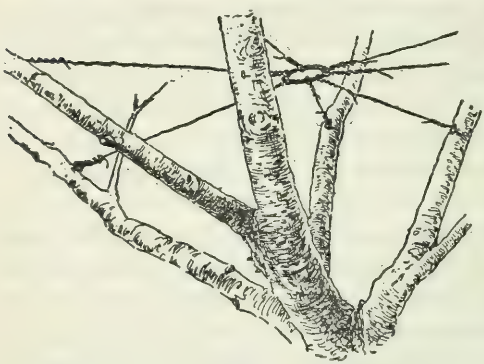

Fig. 12. — A desirable method of supporting the branches to prevent breaking when heavily loaded with fruit.

In Plate XX is shown a convenient form of orchard sled for use in removing the brush from the orchard after pruning, while Fig. 13, which illustrates a "brush burner," suggests still another way of disposing of the brush. This implement consists of an iron frame put together in the form of a sled,

the body being made out of sheet iron. When in use, a fire is started on the bottom, then as it is drawn through the orchard, the brush is thrown into it where in turn it is burned. Another type of burner is similar to this one in its general features but the body is mounted on low iron trucks.

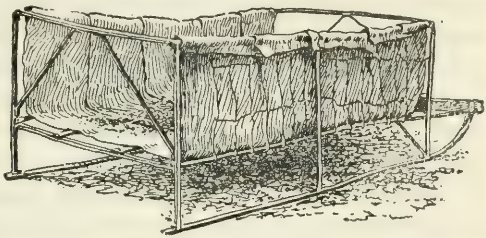

Fig. 13. — A brush burner.

Such a device as a burner obviously could not be used to advantage where there were many large limbs to be disposed of, but when pruning is done regularly and thoroughly each year, there will be few branches that cannot be handled in this manner without difficulty.

SUMMER PRUNING

Pruning in the summer has been touched on briefly in the sections relating to the pruning of trees during the first three years, but it is well to look a little farther into this feature, since during the past few years it has been advocated more or less for peach, apple, and other fruit-trees. Rather frequent reference is made to the subject in the horticultural literature of recent times. Much of this is somewhat academic without the support of real evidence. However, a number of investigators have carried on work along this line, but the results are conflicting. It may be assumed that the principles of summer pruning are not fully understood, or that the practice frequently is not well executed.

Blake[1] has set forth the more important objects of summer pruning as follows: "To improve the form of the tree. To remove 'suckers' and undesirable branches which tend to make the head or top of the tree too dense. To remove the necessity for too severe winter pruning. To encourage and induce fruitfulness."

This summary relates particularly to young trees that have not been planted more than three years and which, therefore, have not yet borne much fruit. The first year in particular after a tree is planted, corrective summer pruning in limited extent may be advantageous in improving the form. Frequently one or two branches will take the lead in growth and if not checked, the tree becomes one-sided and unsymmetrical. If such branches are pinched back a little as soon as it is apparent that the tree is becoming one-sided, the other limbs have a better opportunity to develop. Further, superfluous limbs may start to grow, and the earlier they are removed, the better. Suckers that come from adventitious buds below the ground had better be removed also at once. By thus keeping the young growing tree well shaped throughout the season, the need of very heavy pruning and especially that which calls for the removal of entire limbs of considerable size will be largely avoided.

It follows to some extent that summer pruning is an individual tree treatment rather than one that should be applied to entire orchards. When considerable pinching back of "leader branches" is done, the development of many relatively strong side branches is likely to occur. These should ordinarily be thinned out as soon as the need begins to appear. The first regular pruning, however, should ordinarily be done during the first half of June, excepting

[1] N. J. Exp. Sta. Bull. 231, p. 32.

possibly in the more northern districts where growth is comparatively late in starting, when a somewhat later date may be necessary.

To quote Blake again in summarizing this phase of pruning: "Summer pruning, then, may be said to consist of two distinct operations: The thinning of the new growth including the removal of any water sprouts or suckers, and the pinching back of leading, rapidly-growing shoots.

"Both operations are usually necessary in summer pruning peach trees that are growing rapidly the second summer. The simple pinching back of the tips of the most vigorous shoots results in making the tree more dense and compact, which is the exact thing we wish to avoid. In general, then, where pinching back is practiced some thinning of shoots is also necessary. The exception may occur with a very open spreading type of tree with but little growth in the center, where pinching back will simply check the sprawling or very upright form of the growth without causing the center to become dense.

"Varieties like Greensboro and Waddell require but little thinning when summer pruned under most conditions in New Jersey. On the other hand, such sorts as Mountain Rose, Early Crawford, Niagara, Reeve's Favorite, and Stump form dense, thick tops if pinched back without any thinning of the new growth. The amount of thinning necessary will also depend considerably upon the character of the pruning the previous spring. Where the trees were severely cut back there will be the necessity of more thinning of new growth than upon unpruned trees, as the pruning in the former case will have induced a more vigorous development of new shoots. In other words, the cutting back of a leader in the dormant season will result in the development of two or more vigorous

new shoots near the point where the branch was cut, and if these are all allowed to grow and are pinched back the development of branches will be much too dense."

Keffer[1] has studied the effects of summer pruning peach trees in full bearing. If done early — by the middle of June in the latitude of Tennessee — it may have beneficial results. He observes that the general tendency is for the bearing surface to become more and more remote from the central axis of the tree, the smaller twigs and branches in the center gradually dying.

This author further notes that the fruit-buds form abundantly after the middle of June. From one season's work only he is convinced that early summer pruning of bearing trees, which consists of heading back the main leader branch a few inches and as well also some of the side branches, will result in the growth of many short spurs all along the branches thus headed back and on which fruit-buds will form. In this way the bearing surface is developed within the center of the tree. In case of the very early varieties this type of summer pruning can be done after the season's crop is harvested. In the later varieties, it must be done while the crop is still on the tree. While it is admitted that this treatment of later varieties may result for the time being in the loss of some fruit, by alternating the cutting back, treating some limbs one year and the others the next, Keffer believes the method will prove advantageous for varieties of all seasons. This plan presupposes the keeping of the top well opened so that the spurs will have a full measure of sunlight.

Unfortunately the investigations, as reported, were not continued for a series of years in order to determine the effect

[1] Tenn. Exp. Sta. Bull. 108.

of repeated prunings of this sort, on the same trees, and to work out the details of the method after the first season, but the results in increased fruit-bud formation in the interior of the trees treated one season were so striking in comparison with those not summer pruned that it was assumed apparently that the principle was proved. The results of this type of pruning when delayed till August were disastrous in that very few fruit-buds formed.

Though some investigators, and orchardists as well, have secured well-defined results in favor of summer pruning, others have obtained either negative or adverse results. While it is a question that may well continue to receive thought and consideration by experimenters and fruit-growers, it should be practiced with considerable discretion and caution in commercial orchards, where a crop of fruit is at stake, until the conditions under which it is consistently beneficial are better understood than they are at present. Further, since summer pruning tends to check the growth, but very little at the most should be done the first season after planting as well as on older trees that are making a weak growth.

PRUNING IN RELATION TO WINTER INJURY

The relation between pruning and winter injury may vary in different regions depending on the climatic conditions. It manifests itself principally through the vigor of the trees and in the time when the seasonal growth matures. The effect in this respect is comparable to that of tillage and the time of its cessation for the season. Chandler[1] reports the results of some observations and experiments in Missouri along this line.

[1] Mo. Exp. Sta. Bull. 74.

It has been stated previously that heavy dormant-season pruning tends to induce a vigorous growth of wood the following season. The vigor of the growth is more or less proportionate to the extent of the pruning. Heavy pruning, it has been shown, induces a late growth of wood. The relationship between late maturity and winter injury, especially to the fruit-buds, in regions characterized by warm periods in winter has been discussed under fertilizers (page 169). For a similar reason heavily pruned trees may pass through the following winter in better condition and produce a better crop the next season than trees pruned so lightly that it has no influence in stimulating a vigorous growth, and therefore the trees mature relatively early. Chandler has compared peach buds taken from trees cut back the previous winter into two-year-old wood with buds from trees of which only about one-third of the length of the previous season's growth had been removed, and has found that the breaking of the rest-period of the former was very considerably delayed in comparison with the latter, and therefore the fruit-buds of the heavily cut-back trees possessed a much better chance under southern Missouri conditions of passing through the winter uninjured. In a more northern location, where early maturity of the growth is a factor in hardiness, the very fact that a tree was late in maturing might explain the cause of the buds not passing the winter uninjured.

On the other hand, the same investigator records an experience in an orchard seven years old where a part of the trees were cut back into three- and four-year-old wood while the others were not headed back. The trees severely headed back made a very heavy growth the next season. The following winter only buds enough survived on these trees

to make a very light crop, while on the trees not headed back the winter before enough buds lived to make a very heavy crop. This experience suggests that it is possible to go to extremes, even where moderately heavy pruning is advantageous. In case of these extremely heavily pruned trees, very few buds may have formed, or they may have been so immature that they were killed even by comparatively mild temperatures. In this connection it may be noted that the hardiest fruit-buds as a rule are those that form near the base of the seasonal growth and on the short spurs which develop on two-year-old wood.

In summarizing the relation of pruning to winter injury under Missouri conditions (and the conclusions are doubtless applicable to other regions where the conditions are comparable) Chandler[1] states as follows:

"If the buds are injured by a freeze, coming before any buds have been started by a warm period, the condition that favors the greatest hardiness is to have the tree mature reasonably early the previous season, and to have the buds set well down at the base of the whips, and on short spurs coming out from two-year-old wood. If the buds are killed after having been previously started by a warm period, the condition that favors the greatest hardiness is secured by having the tree grow well up toward the end of the season so as to prolong the resting period, and thus reduce the amount of growth the buds may make on warm days, and to have the heads of the trees open so that buds may form well down to the base of the whips. If the blossoms are killed by spring frosts, the condition that favors the greatest hardiness is secured by having the tree reasonably vigorous with an open head and buds formed well down to the base

[1] Mo. Exp. Sta. Circ. of Information, 31.

of the whips and on short twigs and spurs from the older wood. If the young fruit is killed by very late frosts, the condition that favors the greatest hardiness is secured by having the trees in as vigorous a condition of growth as a healthy five- or six-year-old tree generally makes. The best system of pruning, then, would seem to be to keep the heads of the trees open, and the ends of the branches shortened back some each year, enough to keep the tree in a reasonably vigorous state of growth. Trees in south Missouri will need considerable of this heading back, especially as the trees grow older. In the northern half of the state, and especially in a section where the trees make the most growth, like the hill land around Kansas City, the heading back will have to be done more cautiously for fear of throwing the tree into too vigorous growth. Some heading back should be done, however, each year. The importance of having an open head will be greater in the northern half of the state than in the southern, so far as the hardiness of the buds is concerned, especially if we do any heading back."

PRUNING TO OVERCOME WINTER INJURY

Occasional "test winters" occur in which the temperature drops disastrously low even in peach districts in which the usual winter is entirely favorable to the industry. Such a winter was the one of 1903–1904 and which resulted in injury to many trees in parts of New England, New York, Michigan, and other northern peach-growing regions. Special problems in pruning are presented by such occurrences.

Trees that are thrifty and vigorous will withstand more adverse temperature conditions than those which are in any way depleted. Since trees of considerable age are often

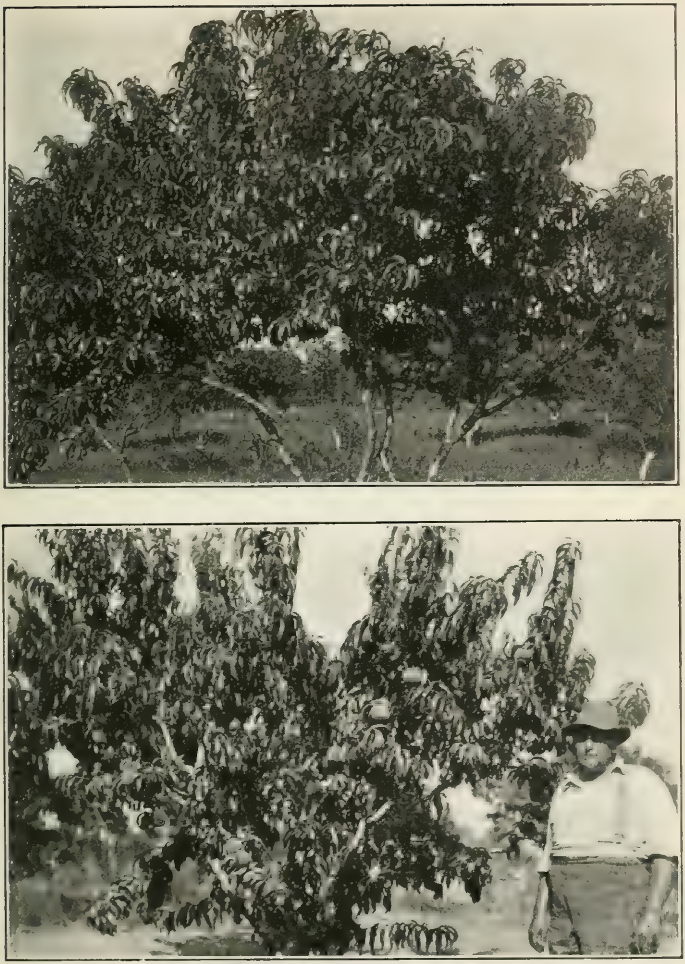

Plate XVII. — Pruning. *Top*, the limbs have not been cut back but the side branches at base of limbs have been removed — a very undesirable form; *bottom*, skillfully pruned Levy peach tree with good bearing surface throughout the top.

more or less depleted and lacking in vigor, it follows that such trees are apt to suffer more from extremely low temperatures than comparatively young, vigorous trees.

Winter injury may appear in every degree from the killing of the fruit-buds, which usually are the first to suffer injury from a low temperature, to the complete killing of the tree. If the buds are killed, the injury can be detected within a day or two after the return of thawing temperatures by cutting them open in the middle lengthwise and noting the embryo peach which occupies the center of each one. If it is bright and fresh in appearance, and the pistil — the very small slender stem-like organ about one-half inch long that extends from the apex of the embryo fruit — is not withered, the bud is in normal condition; but if either the pistil or embryo fruit is dark and discolored, it is doubtless dead.

There is no sure sign by which a tree that has been killed can be detected at once. Both Waite[1] and Eustace[2] have called attention to the fact that a tree injured by low temperatures may show no external appearance of it immediately. Where the ground is covered with snow to some depth when the low temperature occurs, no injury results below the snow line. Above this line the extreme injury that is likely to occur is manifest in the splitting of the bark on the trunk and perhaps the larger limbs and its separation from the wood. When the separation is complete, it is safe to assume the tree is dead or will die regardless of anything that may be done. When the injury is similar to the preceding in kind but the bark is only slightly separated from the wood, experience indicates that the tree may survive and be of service for some years.

[1] Bur. of Plant Ind. Bull. 51.
[2] N. Y. Agr. Exp. Sta. Bull. 269.

An injury still less severe but one that may cause much alarm is when the heart-wood of the tree is killed entirely; the outer surface of the wood is discolored, turning brown or blackened, but the bark and cambium remain intact. On cutting through the bark the discoloration is easily detected. On the strength of this evidence many trees following a "test winter" have been rooted up; but again experience has shown that such trees usually make a good recovery and under favorable conditions produce abundantly for a considerable period thereafter. The cambium develops a layer of sound wood over the dead interior. While such trees are not as strong as normal trees and may break down badly under stress of storms or weight of fruit, they should not be destroyed following the injury on the supposition that they are worthless, unless for other reasons than the one in question.

It is in the skillful pruning of winter-injured trees that much of their future value lies. Eustace found that vigorous trees not over five years old when badly injured made an excellent recovery when the limbs were heavily cut back to comparatively short stubs, but when older trees were similarly pruned it proved fatal. Though they started a new growth, they died almost invariably before the end of summer. On the other hand, when the older trees were only moderately cut back, they made a good recovery, very much better than where no cutting back was done.

These results largely confirm those of Waugh,[1] also observations recorded in Michigan[2] which indicate that cutting back into wood $\frac{1}{2}$ to $\frac{3}{4}$ of an inch in diameter gave much better results both in vigor of growth and in the foliage than either

[1] Mass. Hatch Exp. Sta. Repts. for 1904 and 1905.
[2] Mich. Exp. Sta. Bull. 177, 178, and Special Bull. 11.

cutting back to stubs $1\frac{1}{2}$ to 2 inches in diameter or the usual shortening in as practiced to meet normal conditions.

Walker[1] in Arkansas and Whitten[2] in Missouri, on the other hand, secured by far the best recovery in trees five to seven years old that were headed back to stubs from $1\frac{1}{2}$ to 2 inches in diameter. The lighter heading-in and no pruning at all were much less satisfactory. While Whitten reported that some of the heavily pruned trees were so slow in starting it was thought for a time they would fail entirely to do so, they made very rapid growth when they once began to develop.

It is difficult to harmonize the conflicting results mentioned above. They are consistent, however, with certain differences that have been discussed in another place. In Arkansas and Missouri, where the heaviest heading back proved the best pruning treatment for badly winter-injured trees, the normal winter temperatures are rather mild with occasional decidedly warm spells, while the regions in which the better results followed heading back only to wood $\frac{1}{2}$ or $\frac{3}{4}$ inch in diameter are all located where the normal winter is quite continuously cold in comparison. Whether the differences in the results that have been noted are correlated with the different temperature conditions in the several regions and their influence on the vegetative processes of the trees is impossible to settle on the basis of present evidence.

The pruning discussed under this heading would ordinarily be done in late winter after the effect of the low temperature had become apparent or in the spring before growth starts very much. In many cases, however, it is difficult or even impossible to detect that a tree has been injured by winter conditions. This is true especially where injured trees are scattered here and there throughout an

[1] Ark. Exp. Sta. Bull. 79. [2] Mo. Exp. Sta. Bull. 55.

orchard, as sometimes happens. An injured tree may start into growth in the spring, but the foliage as it develops will be small, below normal in quantity; and the tree shows a general lack of vitality. As this condition may become evident only as the season progresses, its early detection is frequently impossible.

PRUNING TO RENEW THE TOPS

When the fruit-buds are all killed either by excessively low winter temperatures or spring frosts so that trees fail to bear a crop of fruit, it offers an opportunity to rejuvenate them and develop a new supply of fruit-bearing wood. A method of pruning to accomplish this is suggested in Figs. 14 and 15, which show a tree, respectively, before and after pruning. The tree is fairly vigorous with only a limited amount of bearing wood in the interior. By heading back moderately and removing some of the small interior side branches which are probably too weak to produce either fruit or in turn fruit-bearing

FIG. 14. — A peach tree in need of corrective pruning to stimulate the growth of strong fruit-bearing wood in the center.

wood or spurs, good conditions are afforded for the development of new growth which will bear fruit in the interior of the tree. In some cases this course can be followed when the fruit-buds have not been injured, and without destroying all the fruit-bearing wood of the coming season.

This type of pruning should ordinarily be done in the late spring before growth starts.

Renewal by heavy pruning.

Fig. 15. — The tree in Fig. 14 after receiving corrective pruning.

A type of pruning not unlike the heaviest heading back discussed in the preceding section on pruning winter-injured trees is sometimes practiced when there is no winter injury that requires consideration. If a peach tree is not well pruned, especially as to proper heading, and the branches become long and slender; if, as it attains considerable age, the bearing wood, in spite of the pruning which it has received, has grown out of convenient reach for harvesting the fruit; or, if for other reasons it becomes desirable to renew the top of a tree, it may be practicable to do so, provided the trunk and main limbs are sound and healthy. Renewal of the top will often result in prolonging the usefulness of a peach tree for several years. This operation is exemplified by several of the accompanying illustrations.

In Fig. 16 is shown an eight-year-old peach tree which has become rather "leggy." The annual growth for several seasons has nearly all been made near the extremities of the

Fig. 16. — A peach tree eight years old with bearing surface mostly at the extremities of the limbs.

limbs. Very little new wood has grown in the interior of the tree. Figure 17 shows the same tree after being severely headed in, or "deheaded,"[1] with a view to developing a new

[1] The term "dehorn" has been widely used to express this operation. That word is entirely inappropriate and meaningless when used in this connection, even though it may be a perfectly proper and expressive one when used in referring to the removal of a cow's horns. Though this term has been used for many years, apparently with common consent, and without protest by other writers, the term "dehead" is suggested as being much more appropriate and one the use of which is sanctioned at least by its derivation, if not by its appearance in a dictionary.

top. Plate XXI (*right*) shows a seven-year-old Elberta tree which was headed back to about the extent indicated in Fig. 17. This illustration shows the tree near the end of its first season's growth after being deheaded. The vigorous growth which now comprises the top should bear a crop of fruit the next season, thus losing only a single year's product even if the deheading is done when a crop is in prospect. Frequently, however, it is done after the fruit-buds have been killed by

Fig. 17. — The tree in Fig. 16 after being deheaded.

winter or spring temperatures or other unfavorable conditions so that in reality no crop is lost as a direct result of deheading.

The tree in Plate XXI (*right*) will need rather heavy thinning at the annual pruning, as it is too dense. A little could probably be done to advantage during the summer. If a tree which lacks vigor is treated in this way, the results shown in Plate XXII (*left*) may occur. On a portion of the stubs there were no buds strong enough to develop; hence, the top was

only partially renewed. If the tops are cut back to wood that is not more than three or four years old, a stronger, more symmetrical growth may be expected than when the stubs left in deheading are older than the age mentioned. When the bark looks bright and smooth where a limb is cut off, it will generally put out new growth; but if it is dull and rough, it may not be possible for adventitious buds to form from which new growth can develop. Hence the results will be like those shown in Plate XXII (*left*). Occasionally, when the trunk remains sound and retains its vigor, the tops are renewed two or three times. Plate XXII (*right*) shows a tree that has been deheaded three times. As a rule, however, it is impracticable to dehead for renewal more than once.

Sometimes, when for any reason it is desirable to renew the top of a comparatively young tree, the heading back may be made much more severe than that suggested by Figs. 17 and Plate XXII. This is shown in Plate XXI (*left*) where all the branches have been cut back to the trunk of the tree.

The season for deheading to renew the top is the same as that for the annual pruning for the shaping of the trees and the removal of superfluous wood.

Before leaving this phase of pruning it should be stated that it is a radical method of treatment. For reasons which may be local and not readily explained, some peach growers have not had satisfactory results from this method of rejuvenating or restoring peach trees, the trees failing to grow well after being deheaded. Therefore, it may be wise for the grower located in a region where deheading has not been practiced to resort to it rather cautiously until its practicability under his conditions has been adequately tested.

Renewal by top-budding.

For various reasons it is sometimes desirable to change the top of a peach tree from one variety to another. A grower may find after his orchard begins to bear that he has a larger number of trees of some variety than he wants; a block of trees may prove to be some other variety than the one ordered; or a variety is not well adapted to the needs of the owner. In such cases the trees may be top-worked either by budding or grafting to a desirable variety.

The ordinary method of shield-budding described in detail in the chapter on propagation is the one most commonly used for this purpose. If the tree to be top-worked is not more than two or three years old, it is usually practicable to insert the buds directly into the main limbs well down toward the point where they leave the trunk. This is illustrated in Plate XXIII (*bottom*) which shows a Triumph peach tree that was budded to the Carman variety when it was three years old, after its crop of fruit for the season had been harvested. The points where the buds were inserted may be seen by reference to the figure.

If the tree to be top-budded has reached an age when the bark on the main limbs has become too thick and firm to be manipulated readily for budding, it is necessary to head it back heavily with a view to forcing the development of new growth into which the buds of the desired variety can be inserted. This heading back must of necessity be done fairly early in the season, else the new shoots will not attain sufficient size for budding the same season. In the latter case a year might be lost in the top-working. When this course is followed, the buds should be inserted in the new growth as near the trunk or main limbs as is practicable, in order to have as large a portion of the top as possible of the

new variety. This is also desirable on account of the subsequent management of the tree. This operation may be performed at any time during the summer when the bark of the stock slips and the tree is otherwise in suitable condition and when well-matured buds of the desired variety can be secured.

Renewal by top-grafting.

Peach trees are sometimes top-worked by grafting instead of budding. The ordinary cleft-graft method is generally used in such cases. The grafting is done in the spring when stock and cion are dormant, especially the cion. However, budding is to be preferred, especially as the wounds made in grafting do not heal readily in the case of the peach, though when properly done the union of stock and cion is generally strong enough to make a fairly serviceable tree. But troubles incident to the failure of the wounds to heal properly are likely to occur.

Still another means of top-working peach trees is by a method designated as "shield-grafting." It has been recommended by a grower in the Grand Valley in Colorado. The term "side-grafting" would be a more accurate expression. By this method limbs three and four inches in diameter are said to be successfully top-worked. At the point on a limb where a graft or cion is to be inserted, a T-shaped incision is made as in shield-budding on a small seedling stock, the vertical cut being an inch or more long. The cion of the desired variety is taken from wood of the preceding season's growth. The lower end is cut with a long sloping bevel, the cut being all on one side of the cion, and the slope about two inches in length. The length of the cion is so regulated that it shall bear two and only two

buds above the bevel of the lower end. The cion thus prepared, the lower end is inserted in the T-shaped incision and forced or driven down under the bark firmly. One or two very small nails may be driven through the lower end of the cion to bring the cut surface of the bevel into close contact with the cambium of the stock, though if it is firmly bound in position by wrapping strips of waxed muslin about it, the nailing will probably not be necessary. Sometimes the wound is covered thoroughly with grafting wax to exclude the air before the wrapping is done. Top-working by this method should be done in the spring as when the cleft-graft method is used.

After the grafts have started well into growth, the tops of the limbs above the points where grafts are inserted should be removed. In case of especially vigorous trees, the tops can probably be removed with successful results when the grafting is done.

This method of top-working peach trees has never been widely used, but it is said to possess considerable merit under some conditions.

CHAPTER XI

INSECT AND DISEASE CONTROL

From the standpoint of control, both insects and diseases naturally divide into two groups: (1) those that can be controlled by spraying; and (2) those that require some other method of attack. A sub-group might be made in the latter which would include those for which no remedy is known other than the complete eradication and destruction of the affected trees.

The insects that fall into the first group must also be considered from the standpoint of their methods of feeding. If they eat parts of the tree or fruit, they are to be sprayed with an arsenical poison. If they suck the juices of the tree or fruit, they are unaffected by poisons applied to the exterior parts of the tree; hence a substance must be used in spraying that kills the insects by coming in contact with them.

The poison now most largely used in spraying peaches is arsenate of lead. Arsenate of lime (calcium arsenate) is sometimes used instead of arsenate of lead, but is not advised for peaches and other stone-fruits. The contact insecticides most often used are the concentrated lime-sulfur preparations, miscible oils, and to some extent nicotine extracts of tobacco which are effective against certain aphids or plant-lice. These lime-sulfur mixtures are also effective in the control of certain diseases that can be reached during the dormant condition.

The fungicide of greatest value to the peach-grower, however, is self-boiled lime-sulfur mixture. Other sulfur preparations are also used to a limited extent. Bordeaux mixture, for many years the most effective fungicide available to the fruit-grower, was never satisfactory for use on peach trees because of its frequent serious injury to the foliage. The development of the self-boiled lime-sulfur mixture made a new epoch in peach spraying and in peach-growing, since by its use the nearly complete control of certain serious diseases became possible, whereas formerly these diseases served practically as limiting factors in the growing of peaches.

A discussion of the preparation and application of these insecticides and fungicides follows the sections treating of peach insects and diseases. In the discussion of the individual insects and diseases, the aim is to give the grower such information as is needed to enable him to treat them successfully, no effort being made to supply in this connection complete descriptions or life histories.

PEACH INSECTS

Plum curculio (*Conotrachelus nenuphar*)

This insect is also known as "plum weevil," "peach curculio," "peach worm," "little Turk," and by other names. It is the principal cause of "wormy peaches," except on the Pacific coast.

Appearance.

The adult is a small beetle about $\frac{3}{16}$ inch long, characterized by a roughly ridged back and a long snout; the prevailing color is dark gray or black.

Distribution of curculio.

The curculio is distributed from southern Canada to Florida and westward as far as the Rocky Mountains, though of much less importance in the semi-arid regions west of the 100th meridian.

Life history and habits.

The insect passes the winter in the beetle stage under trash on the ground or in other places where seclusion and protection are afforded. In the spring, with the swelling of the fruit-buds the beetles become active again and begin to feed on the buds, unfolding leaves, and blossoms.

Egg-laying begins soon after the fruits commence to form and continues for several weeks or even months, but is most active during the first four or five weeks. Crescent-shaped punctures in the fruit mark the places where the eggs have been deposited. A gummy substance commonly exudes from these punctures, adhering to the exterior of the fruit.

The eggs hatch in three to five days, varying with the temperature. The larva or "worm" bores into the fruit, where it feeds largely about the pit until it completes its growth, which requires from twelve to eighteen days, or longer under some conditions. On completing its growth, the larva leaves the fruit, whether the latter has dropped or still remains on the tree, and enters the soil to the depth of about two inches, where it transforms into the adult beetle, which requires three to four weeks.

There is but one generation in a season; but after the beetles emerge from their pupal cases, they feed on fruit and leaves until cold weather, when they secrete themselves under rubbish in the orchard or in other protected places.

Plate XVIII. — Desirable and Undesirable Forms of Elberta Trees. *Top*, well-pruned, spreading heads; *bottom*, limbs "leggy" and not well formed for sustaining heavy crops of fruit.

Methods of control of curculio.

Jarring. — The habit of the beetles in dropping to the ground, especially in the cool of early morning, feigning death, when a branch on which they may be resting is suddenly jarred, was formerly taken advantage of in collecting large numbers of the adult insects during the period when egg-laying was proceeding most rapidly. Various devices for catching the beetles have been used more or less. However, this method has largely given place to spraying with arsenate of lead and is no longer much used by commercial growers.

Cultivation. — Because of the fragile nature of the pupæ, frequent tillage during the period when the larvæ are transforming into adults may reasonably be supposed to destroy many of them. In the latitude of Washington, the larvæ are beginning to enter the ground to pupate in about six weeks, and in Illinois about eight weeks, after the blossoming period. This continues for several weeks or even months, but much more rapidly during the first four or five weeks after the process begins than later. During this period tillage will be the most effective in destroying the pupæ.

Poisons. — The adult beetle feeds on the fruit and foliage, both early in the season and later after it emerges from the pupa. This offers an opportunity to reach many of the insects by spraying the trees with arsenate of lead. It is applied at the rate of 2 pounds to 50 gallons of water with 2 to 3 pounds of lime added, or it may be used in a like quantity of self-boiled lime-sulfur mixture as a combination spray for both insects and diseases. The directions for making the necessary applications are given in the spraying program on pages 290–292. It is the conviction of some that the effective control of the curculio contributes very materially to the control of brown-rot by

preventing largely the wounds in the skin of the fruit through which the fungus enters.

Peach-tree borer (Sanninoidea exitiosa)

This borer is one of the most serious and destructive insects with which peach-growers have to contend.

Appearance.

The adult insect is a moth somewhat resembling a wasp. The general color is steel-blue, but the two sexes differ considerably. In the male the wings are transparent, with a spread of from $\frac{3}{4}$ inch to $1\frac{1}{4}$ inches. The female is somewhat larger, with the wings transparent in part only.

The insect is more familiar to the peach-grower in the form of the "worm" or larva than in the adult form, since it is in the worm or borer stage that all its damage is done. It attacks the tree at or near the surface of the ground, working under the bark, where it seriously weakens the tree, which, if girdled, as frequently happens, will of course die. Trees of all ages from those in the nurseries to the old wrecks in the abandoned orchards are subject to attack, forty or fifty borers sometimes working at the same time in a mature tree.

Distribution.

This insect is a native species and occurs in Canada and throughout the United States east of the Rocky Mountains wherever peaches are grown. Occurrence west of the mountains has been reported, but its establishment is not certain.

Life history and habits.

The adult moth makes its first appearance about July 1 in the North, but the period of maximum emergence appears

to be from about July 15 to August 15. In the middle latitudes emergence extends from about June 15 to September 15, while in southern latitudes it continues until about October 1. The laying of eggs begins as soon as the moths emerge.

The eggs are too small to be seen readily on the bark of the trunk, where they are laid rather promiscuously as well as on adjacent weeds and trash and even on the ground. They hatch in nine or ten days, and the young larvæ soon begin to burrow through the bark at the surface of the ground into the sapwood, where they continue until full grown, working just beneath the bark and sometimes extending down the larger roots six or eight inches below the surface of the ground.

The full-grown larva is about 1 inch in length with a very light yellow body. There is but one generation in a season, but because egg-laying continues for so long a period, larvæ varying greatly in size may be found in a tree at the same time.

The presence of borers in a tree is indicated by a mass of gummy material which habitually exudes from the burrows at the surface of the ground. It is often mixed with particles of soil and frass. In rainy weather it becomes gelatinous in texture.

Method of control of borer.

Passing mention only need be made of the numerous washes, different methods of wrapping, and the like that have been recommended from time to time. None of these measures, however, is more than partially effective, and many are entirely useless. After an exhaustive investigation of a great number of them, Slingerland of the Cornell Uni-

versity Experiment Station concluded that the simple expedient of mounding up the soil about the base of the tree was one of the most effective and satisfactory methods of prevention. Trees so treated contained markedly fewer borers than others not so treated. Why this should follow is not apparent, since the eggs are laid more or less at random on the trunk.

After trying many washes, gas tar proved in Slingerland's experience the most effective of any in keeping out the borers, and it caused no injury to the trees. However, others have reported considerable injury under some conditions, hence its use in any particular orchard or region cannot be advised until after its effect on the trees has been thoroughly determined by experiment.

Any preventive measure to be effective must be applied prior to the time when the moths begin to emerge in any considerable numbers in the spring and be continued until the period of egg-laying is ended, which is two to three months later. However, there appears to be no method of prevention which is sufficiently effective to eliminate the necessity of digging out the borers.

When they are at all troublesome, "worming" should be done twice a year, — in the fall towards the close of the season and again early in the spring. The second time is for the purpose of finding any borers that may have been overlooked in the fall. In this operation the soil is removed from about the base of the tree to a depth of 6 or 8 inches. Then by carefully scraping the bark with a knife or other suitable implement, the burrows can usually be located without difficulty. To reach the borers, considerable cutting of the bark and sapwood may be necessary; but if done carefully and the channels followed closely,

little serious harm should result therefrom. If the channels or burrows are fairly straight, many of the borers can be reached with a pliable wire without cutting to the point where they may happen to be located. The space about the tree from which the soil was removed should be refilled after the fall "worming," otherwise it is likely to fill with water and injure, or perhaps kill, the tree; or, the crown may be injured by exposure to low temperatures. After the spring worming, it is wise to mound up the soil about the trees to a height of 6 or 8 inches.

S. H. Fulton, West Virginia, finds that the peach-borer can be controlled fairly well by applying to the crown of the tree in the autumn a miscible oil in the proportion of 1 part oil to 4 parts water and in the spring at a strength of 1 to 8. To do this he removes the soil from about the base of the tree as when resorting to the "digging-out" method and in other respects he proceeds as with that method, except that the applications of oil take the place of the digging in the tree otherwise necessary. While this method has not been widely used it appears to be rather promising.

Lesser peach-tree borer (*Synanthedon pictepes*)

This insect has been reported from time to time for many years as working on plum and cherry trees. It is only within the past few years that its full life history has been known. The name "lesser peach-tree borer" was apparently first used by Quaintance in 1905,[1] when its economic importance as a menace to peach trees was pointed out. While showing a preference for peaches, it has many other hosts.

[1] U. S. Dept. of Agr. Yearbook, 1905, p. 335.

Appearance of lesser borer.

Though the lesser peach-tree borer is quite easily distinguished by the entomologists from the common and the California peach-tree borer, its resemblance to these two species both in the adult and larval stages is close enough so that the casual observer may easily mistake one for the other. The wasp-like appearance of the adults, with wings more or less transparent, characterizes this as well as the other two species.

Distribution.

According to King[1] it occurs throughout practically the entire country east of the Great Plains area. In some sections it causes considerable injury.

Life history and habits.

While the life history does not correspond in all particulars with that of the other borers discussed, the differences are unimportant from the standpoint of control. Instead of working at and below the crown of the tree, they occur under the bark and in wounded areas on the trunk and upper branches, the attacks being confined almost entirely to diseased and injured areas. Such areas as are caused by sun-scald, mechanical injuries, and the sharply angular crotches with roughened surfaces are typical places of entrance for the larvæ.

Methods of control.

The digging-out method advised for other borers is the most effective means of control. The "worming" should be done at the same times as for the common peach-tree borer, that is, in October or November and in early spring.

[1] Ohio Exp. Sta. Bull. 307.

Preventive measures, which consist of so managing the orchard that wounded and diseased areas through which the larvæ gain entrance will be avoided, may be expected to be of value.

California peach-tree borer (Sanninoidea opalescens)

This insect is also called the Pacific peach-tree borer.

Appearance.

In appearance this species is very similar to the more common peach-tree borer previously discussed. The larvæ of the two species also look very much alike.

Distribution.

While this insect has been observed at various places in Colorado, Nevada, Oregon, and California, it appears to be noticeable as a serious peach pest, according to Moulton,[1] principally in the Santa Clara Valley in California and in the parts of Alameda and San Mateo counties which lie close around the southern arm of San Francisco Bay, where it does considerable damage.

Life history and habits.

The life history of the California peach-tree borer is similar to that of its near eastern relative. The adults are flying from June to September, but they are the most numerous during July and August. The period of egg-laying is coincident with the period of activity of the moths. The eggs hatch in about two weeks. A larva may enter very near

[1] Bur. of Ent. Bull. 97, Part IV, "The California Peach Borer," p. 66.

the egg from which it hatched or migrate some distance, frequently going below the surface of the soil, especially if it is light or gravelly, and then eating its way into a root. They live usually below the surface of the ground, but may occur in the trunks or larger limbs.

Since the eggs hatch and the borers enter the trees during a period of several months, the size of the larvæ in a tree at any particular time varies accordingly.

Methods of control of California borer.

As in the case of the eastern species, the only effective method of control is "worming," that is, digging out the borers. This is usually performed in the Santa Clara Valley in the winter or spring months, or it may be done in the fall in the manner described for the eastern species.

The application in May or June before the moths begin to fly of a repellent wash termed a "lime-crude-oil-mixture" is recommended as being of more or less value. It is made as follows: "Place about 50 pounds of rock lime in a barrel and slake with 10 or 15 gallons of warm water; while the lime is boiling slowly pour in 6 or 8 gallons of heavy crude oil, and stir thoroughly. Add enough water to make the whole a heavy paste." This wash should be applied as soon as made, using a heavy brush for the purpose.

Fruit-tree bark-beetle, or shot-hole borer (Scolytus rugulosus)

In his account of this insect from which the following notes are taken, Brooks [1] says: "The shot-hole borers or bark-beetles burrow into the bark and slightly into the wood

[1] Farmers' Bull. 763.

in both the larval or grub stage and the adult or beetle stage and, by extending their burrows in great numbers between the bark and sapwood, destroy that vital part of the tree known as the cambium. As a rule, sound, vigorous bark is not attacked, injury being confined to such trees as have had their normal health impaired by some other agency. Cases are not unknown, however, in which the beetles have multiplied greatly in diseased and dying wood and have then extended their attacks to near-by healthy trees, causing extensive loss."

The presence of these insects in peach trees is indicated frequently by the appearance on infested limbs of a mass of gum or gelatinous substance which exudes from each "pin-hole" where an insect is working, or under some conditions the gum may not appear, but the small, circular, clearly cut holes can be readily seen. The weakened, unhealthy appearance of an infested branch is also likely to attract attention.

Appearance.

The adult is a beetle about $\frac{1}{10}$ inch in length and of a dark brown or black color. The larva when full grown is also about $\frac{1}{10}$ inch in length, white in color, with a reddish head. It is in this form that most of the injury is done.

Distribution.

This bark-beetle occurs in practically all of the United States east of the Mississippi River, and in many localities to the west, though it is not known to have occurred in the Pacific coast states; it is also found in Canada.

Life history and habits of shot-hole borer.

The adult appears in the early part of the season from April to June, depending on the latitude, and at once proceeds to gnaw a round hole through the bark where, between the bark and the sapwood, its brood chamber, extending with the grain of the wood, is constructed.

A single female produces, on an average, from seventy-five to ninety eggs. They hatch in three or four days, and the larvæ begin to burrow in the sapwood, working at first in a direction at right angles to the brood chamber. They feed from thirty to thirty-six days and then pupate within their burrows. In the North there are two generations each season; in the South, three or four. The winter is passed in the larval form in the tree.

Methods of control.

Limbs or other parts of trees, once infested, cannot be freed from the insects by any treatment. By cutting off such limbs and burning them, further infestation may be avoided. As preventive measures, good orchard sanitation is important. The trees should be maintained in a vigorous, healthy condition. Trees that are made weak by any means whatsoever are a menace in that they may attract these insects and become a breeding place for them.

All prunings and dead or dying wood from other sources should be removed and burned, as they may harbor the beetles or larvæ.

Sometimes trees otherwise healthy that become moderately attacked can be saved by heading back the limbs rather heavily, then stimulating vigorous growth by tillage and fertilizers. This course prevents such trees from becoming weakened by the initial attacks.

Peach-tree bark-beetle (Phlœotribus liminaris)

This insect is very similar, in many respects, to the fruit-tree bark-beetle, and both the insect and its work may be mistaken for the latter, though there are certain rather characteristic differences.

Appearance.

The beetle is slightly less than $\frac{1}{10}$ inch in length, being a very little smaller than the fruit-tree bark-beetle. In color it is light brown to nearly black.

Distribution.

This species is more restricted in distribution than the fruit-tree bark-beetle. It is known to occur from New Hampshire westward through Ontario, Canada, to Michigan and southward to North Carolina. It may also occur in other sections. Its food-plants appear to be restricted very nearly to peach and cherry trees.

Life history and habits.

From the standpoint of control, there are no important differences between this insect in its life history and habits and the fruit-tree bark-beetle. The adults of the former pass the winter in the burrows in trees, while the latter pass the winter in the larval form.

The brood chambers of the two are characteristically different. That of the fruit-tree bark-beetle runs with the grain of the wood, while that of this species is across the grain of the host. These differences are without importance from the standpoint of control.

Methods of control of bark beetle.

The methods given for the control of the fruit-tree bark-beetle are applicable to the control of this insect.

Peach twig-borer, or peach-worm (Anarsia lineatella)

This insect is commonly called the peach twig-borer in the eastern states, but as its most serious damage in the far West is caused by the larvæ entering the fruit, it is there more often termed the "peach-worm." It is the common cause of "wormy peaches" on the Pacific coast rather than the larva of the curculio which makes "wormy peaches" east of the Rocky Mountains.

Appearance.

The adult insect is a small moth with a wing expanse of about ½ inch. The larva is pinkish or brownish in color, and when full grown is ½ inch or less in length. There are two or three generations during the season in the West.

Distribution.

The peach twig-borer is an insect of European origin. It has become widely distributed throughout most parts of the country during the nearly fifty years since it was first observed here.

Life history and habits.

The insect passes the winter as a minute partially grown larva within a silken lined cell in the spongy bark at the crotches of the limbs. The location of the cell, frequently several placed closely together in the same crotch, is indicated by the presence of very small mounds of finely powdered particles of bark.

PLATE XIX. — PRUNING. *Top*, Salwey trees well pruned with a view to developing large bearing surface; *bottom*, an open head but bearing surface largely at the extremities of the limbs.

With the renewal of tree growth in the spring, the larvæ again become active and, as above indicated, bore into the ends of the young shoots and burrow into the pith for a distance of $\frac{1}{3}$ inch to $1\frac{1}{2}$ inches, causing the death of the terminal end of the shoot.

The larvæ of the generations occurring during the summer attack the fruit, and it is to this habit of the insect that its most serious damage is due. It may bore into the pit if it is still soft when it enters, or it works in the flesh about the pit later in the season. It is the minute, partially developed larvæ of the last brood that pass the winter in the crotches of the tree as above described.

Methods of control.

As a rule orchards that are thoroughly treated according to the usual spraying program for San José scale and curculio require no special treatment for this insect. While some have doubted the value of lime-sulfur mixtures, others have found them successful when applied very thoroughly just as the buds are swelling and starting into growth in the spring. The arsenate sprays for curculio also doubtless destroy many of the small larvæ.

Black peach-aphis (*Aphis persicæ-niger*)

The black peach-aphis is a small, soft-bodied insect closely related to other aphides or "plant-lice" that occur on apples and a great variety of other fruits and plants.

Appearance.

The insect is about $\frac{1}{12}$ inch long and is shiny jet black or very dark brown in color. Both winged and wingless forms occur.

Distribution of black peach-aphis.

Probably this aphis has been more troublesome in the middle and South Atlantic states than elsewhere, but it is known to occur in Michigan, Colorado, California, and Ontario. As it is a native its distribution is likely to be even more widespread than has been definitely recorded.

Life history and habits.

Probably the most serious damage is caused by the wingless forms on the roots, where they may be found throughout the year. If they become numerous on the smaller roots of a tree, as often happens especially during the second and subsequent seasons after planting, they sap its vitality to such an extent that the tree becomes weakened, the foliage is small, scanty, and yellow, and the tree has a generally weak and unthrifty appearance.

The aphides may be found on the affected roots at any time in the season. They are active throughout the growing period. In the spring, with the beginning of growth, some of them crawl to the branches and begin feeding on the new twigs and leaves. In May, in the latitude of New Jersey, the insects may become quite numerous on the new growth, and by this time the winged forms which appear only on the twigs and leaves develop. By June the winged insects are migrating to other trees. These forms produce a brood of wingless insects, which in turn soon make their way to the roots. Thus, by the middle of the growing season there may be no indication on the parts of the tree above ground that the insect is present.

Methods of control.

The first consideration is prevention rather than control. By planting trees free from the insect, the danger of injury

is greatly reduced. Trees that have been properly fumigated with hydrocyanic acid gas when received from the nursery should be clean. Another precaution is to wash from the roots the soil that remains on them before the trees are planted, then dip them in a strong tobacco decoction.

When young trees are planted without these precautions being taken, or if they become infested later, the soil should be removed for a space of a foot or two about the trunk in such a way as to form a basin, then a pound of fine tobacco dust sprinkled in it and covered. As the rains leach the tobacco and the extract soaks down along the roots, coming in contact with the aphides, they are destroyed.

As a rule, treatment of the insects on the twigs and foliage is unnecessary, especially if the root forms are effectively controlled. But if serious injury is threatened, spraying with nicotine sulfate at the rate of 1 ounce to 5 gallons of water, or some other tobacco decoction or extract, usually accomplishes the desired result.

Green peach-aphis (Myzus persicæ)

This insect calls for but passing attention, though in some sections it is rather serious and is more abundant on peaches than any other insect of this group. It is one of the many "plant-lice" having a large number of host plants and is related to the black peach-aphis discussed above. Frequently, early in the spring when the shoots and leaves are young and tender, this insect attacks them, and if very numerous will cause the blighting of the blossoms and the killing of the ends of the new growth.

A contact insecticide must be used in spraying for them, a tobacco extract, of which there are several proprietary preparations, commonly being advised. Spraying should be done before the leaves become deformed; otherwise, after they become curled and misshapen, it will be impossible to reach the insects with the insecticide.

San José scale (Aspidiotus perniciosus)

Perhaps no other occurrence has ever so thoroughly stirred peach-growers as did the appearance and wide dissemination of the San José scale during the 90's and in the first part of the decade beginning with 1901. During these years this insect became generally distributed throughout the country. To it also may be traced, as a primary cause, the fumigation of nursery stock with hydrocyanic acid gas now widely practiced by nurserymen. The most frequent means of dissemination of the scale to new localities is through the sale of infested trees. Also the San José scale is largely responsible for the present nursery and orchard inspection laws that have been enacted by nearly every state in the Union and in the provinces of Canada.

Appearance.

The appearance of the San José scale is too well known to require any extended description. Briefly stated, the massed effect of a large number on a branch or twig is that of a grayish coating of a greasy, waxy substance, which when scraped off in quantity appears to be more or less mixed with very small yellowish specks. These specks are the insects themselves, and the grayish waxy substance is made

up of the "scale" that is secreted by each insect very early in its life as a protective covering. Individually each female insect when fully mature appears to be a minute circular grayish speck or "pimple" not as large as a pinhead with a nipple-like prominence in the center. What is actually seen is, of course, the "scale" under which the yellowish colored insect itself resides. The male insect, that is the scale, is considerably elongated in form.

Distribution of San José scale.

The San José scale has become so widely disseminated that it may be said almost literally to be unrestricted. It is likely to occur wherever peach trees are grown.

Life history and habits.

This insect passes the winter on the bark of the host plant, a large proportion of them in a more or less immature condition. In this stage the scales are dark gray to blackish in color. With the renewal of the growth of the tree in the spring, the insects resume their development, and within a month or so the females begin to bring forth living young. These are exceedingly small, yellowish insects hardly discernible with the naked eye. They crawl about for a few hours only, when they become permanently fixed on the bark, foliage, or fruit, as the case may be. The protective scale is then secreted, or it may begin to form even before the insect locates permanently. When it finally settles down, the insect penetrates the bark with its long thread-like beak and begins to suck the sap by which it is nourished. When an insect once becomes fixed in a particular spot, it has no power to move further from place to place.

A single female may produce 300 to 400 young, and as there are several generations each year, depending on the length of the growing season, the progeny of one insect may become almost inconceivably large.

The primary injury is caused by the insects sucking the juices from the host plant; but the punctures in the bark made by the beaks of the vast number of the insects which sometimes occur evidently poison the tissues, as indicated by the inner bark showing a reddish discoloration, thus still further effecting serious and speedy injury.

Though the younger limbs are especially affected, every part of a peach tree above ground on which the bark has not become roughened with age may become incrusted with the scales. Not infrequently on young trees the infestations may even extend somewhat below the surface of the ground.

Methods of control of San José scale.

While many different substances have been and still are being used in spraying for this insect, the standard remedy in most regions has come to be a concentrated lime-sulfur mixture, either home-made or commercially prepared. Directions for making and using this mixture are given on pages 279–282.

Other preparations include kerosene emulsion, various petroleum oils, miscible oils, and a considerable number of proprietary preparations put out under trade names.

The principal spray applications have to be made during the dormant season, since the spray must come in contact with every insect in order to kill it, and because of the practical impossibility of making the applications with sufficient thoroughness to be effective when the trees are in full leaf. Besides, an insecticide that is strong enough

to kill the insects beneath their protective scale covering will seriously injure the foliage.

Spraying may be done in the fall, or during mild periods in the winter when it is practicable to work in the orchard, or in the spring before the buds have swelled very much. Badly infested trees are sometimes sprayed twice, in the fall and again later. Such trees may well be headed back considerably to increase the thoroughness of the spraying, since it is practically impossible to cover the small limbs completely with the spray mixture.

Fumigating nursery stock.

As previously stated, one of the most common and far-reaching means by which the San José scale has been disseminated has been through the distribution of infested nursery stock. To overcome this menace to the fruit industry, a method of treating nursery trees with hydrocyanic acid gas before they were shipped from the nursery was worked out early in the history of this insect in the East. This treatment is required by law in some states.

The requisites for efficient fumigation of nursery stock are: (1) a gas-tight box or building (depending on the amount of stock to be treated) in which the trees are placed; (2) a supply of potassium cyanide, 98 to 99 per cent pure; (3) commercial sulfuric acid testing about 66° Baumé, that is, a grade approximately 93 per cent pure; (4) water.

Many nurserymen have constructed houses especially designed for this purpose into which a wagon loaded with nursery stock can be run and treated without unloading.

Trees that are to be treated should be in a dormant condition and should not be wet, that is, no free moisture should be on the surface.

The dosage that has been found most satisfactory is as follows:

For 100 cubic feet of space —
Potassium cyanide, 1 ounce (by weight).
Sulfuric acid, 1 ounce (fluid).
Water, 3 ounces (fluid).

The trees are placed in the fumigating box or room, the proper quantities of the materials are measured out very accurately in accordance with the size of the box or room, and then combined by first placing the water in a suitable container, then adding the sulfuric acid, and finally the potassium cyanide. The best container in which to generate the gas is an earthenware vessel having a capacity considerably greater than the combined quantities of the materials used. The trees should be treated for at least forty minutes.

On account of recent difficulties in obtaining potassium cyanide, sodium cyanide has been used to some extent in its place for fumigating nursery stock and with equally good results. The pure chemical yields considerably more gas to a given weight than the same weight of a pure potassium cyanide. The purity of the former is expressed in terms of the latter. Hence, a grade of sodium cyanide designated as 126 to 130 per cent pure is equivalent to a grade of potassium cyanide of 98 to 99 per cent purity. Therefore, in using sodium cyanide, about one-fourth less by weight is needed for a given unit of space. The proportion of chemicals advised when this substitution is used is:

For 125 cubic feet of space —
Sodium cyanide, 1 ounce (by weight).
Sulfuric acid, 1½ ounces (fluid).
Water, 2 ounces (fluid).

Potassium cyanide taken internally is one of the most deadly poisons known. Hydrocyanic acid gas, if inhaled, is no less destructive of life. Hence, in handling the chemicals and in all details relating to the generation of the gas, the strictest precautions against accidents must be taken.

White peach-scale, or West Indian peach-scale (Aulacaspis pentagona)

Owing to its general occurrence in the West Indies, this insect was at one time supposed to be native there, hence its name. It is now known, however, to be widely distributed in many parts of the world.

Appearance.

A full-grown female scale is about $\frac{1}{10}$ inch in diameter, dirty white in color and nearly circular in outline. The scale-covering of the male is elongated and whiter in color than that of the female.

Distribution.

Though probably not occurring in a large number of commercial peach districts in the United States, this insect is widely distributed from the District of Columbia southward. Its range westward does not appear to have been recorded.

Life history and habits.

The winter is passed in the mature form. In the latitude of Washington, egg-laying begins about the first of May. The eggs hatch in a few days, the young soon settle down, the protective covering is developed, and by the middle

of June the females of the first brood are mature. There are three broods in the District of Columbia, probably four or five in Florida.

The white peach scale attacks practically all stone-fruits, but its chief economic importance is as a peach insect. Because of its rapid increase it is capable of doing much damage. Its general effects on a tree are like those of the San José scale.

Methods of control.

The methods of control given for the San José scale are advised by Quaintance [1] for this insect.

Terrapin scale, or peach-lecanium (Eulecanium nigro-fasciatum)

In his discussion of this insect, Smith [2] has pointed out clearly some fundamental differences between it and other well-known scale insects of which the San José scale is the most familiar. These differences are important from the standpoint of control measures and are as follows:

"This is locally known as the peach soft scale and, while in a general way it has the same method of causing injury that we find in the San José scale, there is a very great difference between the two. The San José scale belongs to the armored scales, in which the true scale forms only a covering that shelters or protects the real insect that lies beneath it. Scale and insect are quite separate and the covering scale can be removed without necessarily disturbing the creature that lies beneath it. In the soft scales, scale and insect are one, and the term scale

[1] U. S. Dept. of Agr. Yearbook, 1905.
[2] N. J. Exp. Sta. Bull. 235.

insect is literally and absolutely applicable; the scale is merely the hardened skin or outer covering of the insect itself."

Appearance.

When fully grown this insect is about $\frac{1}{8}$ inch in diameter, and when viewed from the side its body presents an almost hemispherical outline and is of a brownish color.

Distribution.

This insect has been mentioned by entomologists during the past ten or twelve years as occurring in nearly every state east of the 100th meridian. It also has been reported from Ontario. However, in Maryland, New Jersey, and Pennsylvania it has become of pressing economic importance as a peach insect. Many growers in those states regard it as a greater menace to peaches than any other scale insect, not excepting the San José scale.

Life history and habits.

The life history of the terrapin scale is complicated, but the details are unnecessary in this connection. Smith, cited above, gives the following summary:

"About the middle or toward the end of May oviposition begins, the eggs remaining under the female, which gradually shrivels until it forms only a grayish cover to the mass of eggs beneath it. The larvæ begin to hatch during the middle or latter part of June and remain active for some days, eventually setting or fixing on the leaves, along the veins of either the upper or lower surface. They are, in this stage, elongate oval, greenish, flattened creatures, which retain their general form and shape even after they begin feeding and attach themselves to the leaves. Unlike the armored scales, they do not lose their

legs, and it is quite possible for the young specimens to leave one spot and go to another. Sometimes, but not often, they do this. For a period of six or eight weeks the insects remain on the leaves and during that time more or less honey dew is produced. Upon this a soot-fungus grows which seriously impairs the growth of the foliage and ruins the fruit. The development is very slow and irregular, and I have found in mid-August eggs, recent larvæ, well developed sets and male pupæ all on the one tree."

The most serious injury caused by this insect is due to the deposit on the fruit, leaves, and branches of a sweet, sticky secretion known as "honey dew." A black, sooty-appearing fungus develops in the honey dew, thus making the fruit so unattractive in appearance as to be unsaleable. This applies especially to the later varieties, since the earlier sorts are harvested before the deposits of honey dew become extensive.

Methods of control of terrapin scale.

A number of predacious insects attack this Lecanium and it also has several parasitic enemies, but these are not sufficient as a rule to hold it in subjection. Remedial measures have often proved unsatisfactory on account of the very complete protection afforded by the naturally secreted protective covering. The lime-sulfur mixtures, so useful in controlling San José scale and many other insects, have proved ineffective. Symons [1] found that miscible oils, of which there are several standard brands on the market, applied at the rate of 1 part oil to 15 parts water, just before the buds start in the spring, gave satisfactory results. These results have been confirmed by extended use in commercial

[1] Md. Exp. Sta. Bull. 149.

orchards. Though slight injury to the trees sometimes follows, it may be reduced to a negligible degree by treating only those trees that are known to be infected with this insect. The slow dissemination of the insect from tree to tree makes such a procedure practicable.

The Bureau of Entomology [1] has reported some promising preparations, one of the best of which is a linseed oil emulsion. Its preparation and use are described in the section on insecticides (pages 283–284).

Peach- and plum-slug (Caliroa [Eriocampoides] amygdalina)

For some years this insect has been observed in certain localities in the South, where it sometimes causes serious defoliation of peach trees.

Appearance.

The adult is one of the "saw-flies" which are small, transparent-winged insects, commonly with bodies about $\frac{1}{4}$ inch long and with a wing expanse of about $\frac{1}{2}$ inch. In the larval or "slug" stage, in which it causes injury, it is indistinctly pear shape, the body tapering from the head backward. When fully grown, the slug is about $\frac{3}{8}$ inch in length, of a greenish color, and covered with slime.

Life history and habits.

The adult appears in early spring and begins laying eggs on the foliage. The eggs hatch in about five days. The larva or slug feeds on the under side of the leaves, eating all the tissue between the veins except the upper epidermis. The

[1] U. S. Dept. of Agr. Bull. 351.

feeding period for each individual averages about nine or ten days. When numerous, much of the foliage may be destroyed. Several generations occur during the season.

Methods of control of slug.

Orchards that are well sprayed for the control of the major insects are not likely to suffer from the peach slug. It is only the trees in the home orchard or garden which ordinarily receive scanty attention that are in danger of injury from it.

The pear- and cherry-slugs, both of which are similar in general features to this insect, can be destroyed by dusting them with air-slaked lime; or even very fine dry soil, if dusted over the slimy bodies of the larvæ, is usually sufficient to kill them.

Peach saw-fly (*Pamphilius persicus*)

While not of serious economic importance, this insect has been locally troublesome in a few sections.

Appearance.

The adult is a small, four-winged fly about $\frac{3}{8}$ inch long, reddish brown in color with yellow markings on the head.[1] The larva is about $\frac{5}{8}$ inch long when fully developed and of a bluish-green color.

Distribution.

Apparently the distribution of the peach saw-fly is fairly wide, having been reported as working on peaches in Connecticut and in Nebraska.

[1] Conn. Exp. Sta. Ann. Rept. 1907.

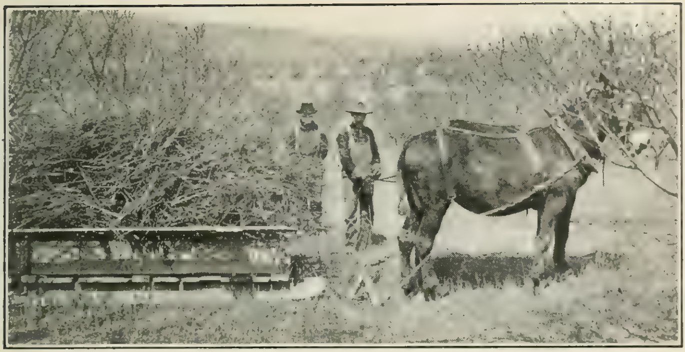

PLATE XX. — *Top*, a sled used in removing brush from an orchard; *bottom*, Phillips peach trees with dense tops but not seriously objectionable when the fruit is to be canned. Limbs propped to prevent breaking from weight of a heavy crop.

Life history and habits.

The adult emerges from the ground the last of May or early in June in Connecticut. Most of the eggs are laid subsequent to the middle of June, being deposited on the under side of the leaves. They hatch in about six to eight days. The larva eats out a narrow strip from the edge of the leaf, working towards the center in such a way as to permit the making of a case for itself. In this the larva remains during the day, feeding mostly at night.

The larva reaches maturity in about ten days and then enters the ground to pupate. There is but one generation in a season. The amount of damage is in proportion to the abundance of the insects and the consequent defoliation of the trees.

Method of control of saw-fly.

In commercial orchards this insect has been well controlled by spraying with arsenate of lead just after the eggs hatch. It is suggested that 2 pounds of the poison to 50 gallons of water would probably be sufficiently strong. However, when arsenate of lead is used on peach foliage in water as a conveyor, rather than in a fungicide containing lime, the latter should be added at the rate of 2 to 3 pounds for every 2 pounds of the poison in order to prevent burning the leaves.

Brown-mite (*Bryobia pratensis*)

This is a very minute insect, as its name suggests. It has various host plants and in some sections does considerable damage to peaches, though as a peach insect it is not widely recognized as a serious cause of injury.

The insect passes the winter in the egg stage, the eggs being placed in or near the crotches of the branches. They hatch early in the following spring. At first the mites are reddish in color, but after feeding for a short time and molting, they take on an olive green or brown color.

Feeding is mostly on the leaves, but sometimes the fruit is attacked. Its presence on the leaves is indicated by a faded out, pallid appearance and by the presence of very minute, dark colored specks of excreta.

Methods of control of brown-mite.

The tobacco extracts generally are effective in killing the insects, but as they have little or no effect on the eggs, they are not satisfactory, since eggs are more or less continuously present in considerable numbers on badly infested trees. However, a spray composed of 10 pounds of flowers of sulfur and 50 gallons of water applied in early spring after the presence of the insect on the foliage becomes evident, is very successful, as reported by Weldon.[1] The presence of the sulfur on the affected parts seems to kill the mites as they hatch, but the adults do not succumb at once. However, within a week after an application was made, practically no adult mites were to be found. Commercially prepared forms of lime-sulfur mixture also proved about equally successful.

Red-spider (*Tetranychus bimaculatus*)

This insect — also one of the "mites" — is common on many fruit-trees and in greenhouses. It is not widely recognized as a serious peach pest, but it occurs to a damaging

[1] Colo. Exp. Sta. Bull. 169.

extent in some sections. As a peach insect it has been discussed by Weldon.[1] Unlike the brown-mite, this insect passes the winter in the adult form, hibernating in the soil close to the trees on which it has been feeding or under rubbish that will furnish protection. It does little damage after the middle of August under the conditions in the Grand Valley in Colorado, migration to the ground having largely taken place by that time.

It works mostly on the foliage, where its effect is not unlike the injury caused by the brown-mite, except that the injured leaves are inclined to turn yellow in spots. The insect is greenish in color while feeding on the leaves, turning orange or red when migration occurs.

The red-spider, unlike the brown-mite, spins a web on the leaves or branches, where it may be located, thus making its presence more conspicuous than it would otherwise be.

Methods of control.

Sulfur, whether dusted thoroughly on the foliage or applied as a spray in water, gives successful results. If applied as a spray, the sulfur should be very finely pulverized or screened, and if a small amount of soap is dissolved in it a better mixture is secured.

Oriental peach-moth (*Iaspeyresia molesta*)

This insect appears to have been introduced within recent years and is not only new to this country but a species new to science. Its nearest well-known relative in this country is the common codling-moth—the familiar cause of "wormy apples." Its entomological position and economic impor-

[1] Colo. Exp. Sta. Bull. 169.

tance have recently been set forth by Quaintance and Wood.[1]

At present its known distribution in this country is confined to the District of Columbia and its near environs in Maryland and Virginia and to a few recently discovered centers where it has evidently existed for several years. While it has been observed to attack different species of plums and cherries, its preference for the peach appears to be rather decided.

The work of the "worm" or larva on peach trees is very like that of the peach twig-borer previously described. Some of its characteristics are similar also to that insect. For instance, a single larva may bore into the terminal shoot of several branches. As the twigs harden the worms may feed more or less on the exterior, since they seem to prefer young tender shoots, and work in them until new ones cease to develop for the season. The places where feeding occurs on the exterior of the twigs are often marked by the exudation of gum.

As a peach insect its work in the fruit is of very much more serious import than its damage to the growth of the tree. While there is an abundance of tender growing shoots the fruit appears largely to escape, but when the period of most active growth is past the worms become a serious factor in the fruit. Thus the early varieties are not much infested, while with some of the midseason and especially the late varieties practically all the fruit has been infested in some cases.

In attacking the fruit, the worm usually eats through the skin near the attachment of the stem to the fruit, or at some

[1] Journal of Agr. Research, Vol. VII, No. 8 (Nov. 20, 1916), pp. 373–377.

roughened spot such as a curculio sting or a hail scar. The larva feeds in various positions in the fruit. Brown-rot is likely to attack the fruits thus injured, and it may fall to the ground, though much of the infested fruit remains on the tree. If its work progresses far enough in the fruit its presence may be apparent, but in much of it, especially if entrance is made near the stem, the presence of a worm is unsuspected so far as any apparent external evidence is concerned.

There are probably two or three broods in a season, but the insect in its various stages may be found throughout the season.

The seriousness of this peach moth as a peach menace rests in the two facts of its apparent ability to cause great damage both to tree and fruit, and in the absence at present of any known method of control.

Peach bud-mite (*Tarsonemus waitei*)

This insect is a menace to nursery stock rather than to bearing peach trees, but brief reference to it in this connection seems not out of place.

For the past twenty or twenty-five years, occasional instances have been reported of serious trouble with peach nursery stock which manifested itself in the young trees becoming very much branched, the small secondary laterals in turn frequently branching profusely as well as the main limbs. As a result the trees are dwarfed and fail to grow to the required height and because of their inferiority are unsaleable.

It has been quite conclusively proved that this trouble is due to the killing of the terminal bud of the twigs by the very minute insect or "mite" here in question.

An injury supposedly due also to this insect sometimes occurs early in the spring to peach stock budded the previous season, just as the dormant bud starts into growth. As a result, the bud which has apparently passed the winter in good condition fails to develop, evidently being killed by this mite.

Methods of control of bud-mite.

The life history of this mite does not seem to have been fully determined, and means of control have not been well worked out. Promising results have been claimed from spraying in the dormant season with a lime-sulfur mixture.

Good results have followed wise pruning after the laterals have begun to develop subsequent to the killing of the terminal buds. By selecting the best branches and removing all others not desired in forming the top of the tree, a fairly high percentage of saleable trees have been secured from stock that would otherwise have had little or no market value.

Other insects

Many other insects besides those that have been discussed attack the peach, either the tree or the fruit. These other insect pests are, for the most part, local in their distribution, or their principal host is something other than the peach, and the attacks on the latter are incidental or perhaps accidental. Or, if they are essentially peach insects, their work as such is rarely observed, and they require no individual consideration, being held in subjection in the regular treatment for the major insect pests.

It should be pointed out that new insects appear from time to time, or for some reason an insect that has been

present for an indefinite period as a minor and unimportant pest suddenly becomes a serious menace. Therefore the peach-grower should be ever on his guard for new insects, and on discovery he should take steps without delay, to ascertain definitely their significance. It is only by so doing that he can fully safeguard his interests.

The nematode (Heterodera radicicola)

This pest has a large economic relation to successful peach-growing in the warmer parts of the country where there is but little freezing of the ground during the winter. Where the ground habitually freezes in winter to a considerable depth, nematodes do not occur in sufficient numbers to be of economic importance.

This organism is a very minute, practically microscopic, worm-like object which infests the roots of a great number of plants, causing knots to develop on them sometimes in great numbers if the nematodes are abundant. These knots are often confused with the nodules formed on the roots of legumes by the nitrogen-gathering bacteria. If peach trees infested in the nursery with nematodes are planted, they are likely to prove disappointing. They may make a lingering, sickly growth for a year or two, but early failure is probable. Trees that are free when planted, if set where the soil is infested, are not likely to succeed. The knots that develop on the roots interfere with their normal functions, hence the tree becomes weakened and the roots die where badly infested.

Methods of control.

Control measures are largely preventive in their nature. Trees free from nematodes, planted in uninfested land, are

prerequisite for successful peach-culture in regions where nematodes are prevalent. Since many vegetables and other economic plants are susceptible to nematodes, they should not be used as interplanted crops on land free from nematodes in sections where they commonly occur. Clean cultivation should be followed, since many weeds also are subject to nematodes. Most varieties of cowpeas are attacked by the nematodes, and many growers are reluctant to use this crop for maintaining the fertility of the soil where otherwise they could be grown in an orchard with great advantage to the trees. However, the Iron and Brabham varieties of cowpeas are practically immune to nematodes, hence may be used with comparative safety, as described in the chapter on cover-crops.

Land that becomes infested with nematodes can be freed from them only by starvation treatment, either by preventing all vegetation from growing for a sufficient length of time or using a rotation of crops all of which are immune to them, but obviously this method is impossible of application in a peach orchard.

By using nitrogenous fertilizers and making the soil very fertile, an infested peach orchard, if the trees have previously become well established, may sometimes be made to thrive fairly well, provided other conditions of growth are favorable.

An effective method of rendering infested soil comparatively free from nematodes has recently been described by Watson,[1] which consists of applying "cyanamid" or calcium cyanamide to the soil, followed by irrigation, but the expense of this material in the quantity in which it has to be used, and its injurious effects for a time on the soil, are

[1] Fla. Agr. Exp. Sta. Bull. 136.

such as to render it impracticable or even impossible where the land is already occupied with trees.

PEACH DISEASES

The number of major peach diseases, those of large economic importance which have to be specifically considered in making up a program of operations with a view to controlling them, is not large, though the peach is subject to many different fungous troubles and other kinds of disease. The larger proportion of these, however, are not of great concern to the peach-grower. They are spasmodic in occurrence, local in distribution, or they are controlled by the same treatment that is provided for the major diseases.

The following discussion is intended to give the grower the essential characteristics of those peach diseases which, within the range of the average experience in the different peach-producing regions, are likely to require his attention.

Brown-rot (Sclerotinia fructigena)

According to Scott and Quaintance — "the brown-rot probably causes more loss to peach-growers than all other maladies of the peach combined, with perhaps the exception of 'yellows,' which kills the trees outright." [1] Brown-rot is also very serious at times on other stone-fruits, entire crops of plums and cherries sometimes being destroyed by it. There is considerable difference in varieties of the different kinds of fruits affected with regard to relative susceptibility to this disease.

The disease occurs throughout the humid regions and may appear in the drier parts of the country. An intimate

[1] Farmers' Bull. 440.

relationship exists between its development and certain weather conditions. If rainy or hot and muggy, especially for a week or two before the ripening of a variety, nearly the entire crop may become infected and lost.

Course of development of brown-rot.

"The disease appears on the fruit as a small circular brown spot, which under moist, warm conditions enlarges rapidly, soon involving the entire fruit in decay. The spots do not usually become sunken, and the fruit remains plump until almost entirely decayed. The fungus growing in the tissues of the fruit breaks through the skin, forming small, grayish tufts of spore-bearing threads. These tufts, although few on young spots, soon become so numerous as to give the diseased area a grayish, moldy appearance, which is responsible for the term peach 'mold' sometimes applied to the disease. The spores which are produced in great abundance by these fungous tufts are blown by the wind and carried by insects and birds from fruit to fruit, tree to tree, and orchard to orchard. Finding lodgment on the fruit under favorable conditions of temperature and moisture, these spores germinate, producing a fungous growth which ramifies and kills the tissues. These dead tissues turn brown, and the fungus breaks through the surface, producing another crop of spores. The process is very rapid, only a few days intervening between one generation of spores and another."[1]

Methods of control.

The development of the self-boiled lime-sulfur mixture by W. M. Scott[2] in 1907 made a new epoch not only in

[1] Farmers' Bull. 440. [2] Bur. of Plant Ind. Circ. 1.

peach spraying but in the peach industry. By the proper use of this preparation brown-rot is almost completely controlled. Directions for its preparation and use appear on page 285.

It has been observed in some cases that the control of the curculio very greatly lessened the prevalence of brown-rot. The fungus finds ready entrance into the fruit through wounds in the skin. The wounds made by the curculio in feeding and in laying its eggs, therefore, offer points of entrance for the fungus which do not occur on fruit not attacked by this insect.

Peach-scab (*Cladosporium carpophilum*)

This disease, known also as "freckles," "black-spot," and by other names, is second only to brown-rot in its destructiveness of the fruit. In some of the mountain districts it causes even greater loss than brown-rot. It occurs practically everywhere that peaches are grown.

While the great economic importance of this disease is in the damage it causes to the fruit, it also attacks the twigs and the foliage.

Course of development.

In outlining the development of this disease Scott states substantially as follows: "The scab fungus which grows in the skin of the fruit produces small, circular, dark-brown spots, one eighth of an inch or less in diameter. Several spots may coalesce, forming large, irregular scab areas. In bad cases the fruit becomes sooty in appearance and the skin cracks.

"The fungus also attacks the twigs, producing small brown spots, which are common in most peach orchards. The

twigs may be somewhat weakened by the disease, but the injury is evidently very slight.

"The results of spraying experiments indicate that fruit infections begin to take place from three to four weeks after the petals fall, although the spots do not appear until about three weeks later. In some experiments spraying with a fungicide four weeks after the petals fell almost completely prevented the disease, while a similar treatment one week later on an adjacent plot of the same variety was only about half as effective. Infections may continue to take place until about a month before the fruit ripens. It is a green fruit disease, however, and it is doubtful whether the nearly mature fruit is susceptible."

There is a wide difference in the susceptibility of varieties to scab, though none is immune. In general the later varieties are more seriously affected than early sorts, but this may be due to the course of development rather than the direct result of partial resistance.

Methods of control of scab.

The self-boiled lime-sulfur mixture is practically a specific for this disease. Directions for making the applications are found in the spraying program on pages 285–286.

Leaf-curl (Exoascus deformans)

Peach leaf-curl is widely disseminated, occurring more or less in practically all peach-growing regions of the country, but more especially perhaps in the northern districts. As the name implies, this disease affects the leaves, causing them to become very much thickened and greatly distorted. The twigs, also the fruit, may be attacked; but the

Plate XXI. — After-Results of Deheading. *Left*, renewal from the trunk following removal of entire top; *right*, a symmetrical vigorous growth near the end of first season after being deheaded as in Fig. 17, page 213.

effect on these parts as a rule is relatively unimportant, though the small twigs are sometimes killed thereby.

Course of development.

The affected leaves gradually turn yellowish, finally blacken and drop off, though in the course of these changes certain areas of the leaves assume a mealy or frosted appearance, due to the growth of the spores by which the disease is perpetuated. The disease works largely in early spring, as the new leaves are developing. The occurrence of cold damp weather is favorable to its development and in some cases the early infections result in affected trees becoming entirely defoliated. This depletes the vitality of the trees, and where it occurs for several seasons in succession, they become weakened thereby to a serious extent.

Methods of control of curl.

Apparently the leaves become infected as soon as they begin to unfold or possibly even before, since spraying after the foliage is partially developed has little or no effect in controlling the disease. Trees that are systematically sprayed during the dormant season, especially shortly before the buds begin to open in the spring, with lime-sulfur mixture (dormant strength) for San José scale do not ordinarily suffer from this trouble. When spraying is done for this disease alone, bordeaux mixture applied very thoroughly about two weeks before the buds open seems to give the highest measure of protection; in fact, it usually holds the disease in practically complete control. Or the lime-sulfur preparations applied at this time or during the winter, or even in November or early December, usually give a high degree of protection.

Peach-yellows (Cause unknown)

This disease has long been a serious menace to the peach industry. The regional progress of the disease has been gradually southward, now having reached as far as North Carolina and Tennessee, and westward to the Mississippi River. In all of the important peach-growing districts within the area thus indicated, this disease has in the past wrought unmeasured havoc, entire orchards and the interests in whole communities having been destroyed thereby. This, however, was before its infectious or contagious character was understood and methods of control established. The cause of the disease and the means by which it is spread have never been determined.

Course of development.

Usually the first evidence of yellows in a bearing tree is the premature ripening of the fruit; ripening may occur from a few days to possibly two weeks or more in advance of the normal time. Usually this occurs first on a part of the tree, frequently on only a single limb, while the fruit on the remainder of the tree appears perfectly normal in all respects. The premature fruit usually shows characteristic small red spots on the surface which mark the location of red streaks that extend to the pit. Moreover, such fruit, especially if it ripens considerably in advance of its normal time, is usually small, insipid, sometimes bitter and altogether undesirable.

Other symptoms follow in succession. The next year the entire tree may ripen its fruit prematurely and begin to show lack of vigor and thrift. Adventitious buds develop on the trunk and larger limbs from which grow slender,

wiry or willowy, yellowish green shoots which become very much branched, forming a sort of brush-like growth. The leaves on this growth are very much smaller and narrower than normal leaves, more pointed, and possess a weak, sickly, greenish-yellow appearance. In the late fall the outermost leaves that develop near the terminal ends of all the current season's growth have some of the characteristics of those borne on the wiry shoots above mentioned.

"Yellows" trees may go into the winter with their buds more advanced than normal individuals and such trees usually start into growth in the spring in advance of healthy ones.

From the beginning of the first symptoms progressing through the various stages described, the entire course of the disease may be run and the tree killed in three or four years. The tree does not die usually all at once but more or less gradually limb by limb.

As above stated, the means by which the yellows is spread from a diseased tree in an orchard to healthy trees is unknown. In the past one of the most common means of dissemination into new localities has been by infected nursery stock. However, the danger of spreading the disease through nursery stock is now slight compared with what it was formerly, since all progressive nurserymen are fully aware of the baneful results that follow any carelessness in respect to selecting the buds used in propagation.

It should be noted that other influences than yellows may cause the development of many of the symptoms of this disease. Premature ripening of the fruit may be caused by girdling a tree or a limb, but the characteristic red markings on and in the fruit are lacking. Weak sickly shoots with narrow leaves may develop also from girdling, as by

a label wire. Girdling may cause the premature dropping of the leaves and the advanced development of the buds in autumn which is also characteristic of yellows in many cases. Such trees are likely to start growth and blossom the next season in advance of others not so affected. Winter injury to the tree, however, may also cause some of these symptoms.

Means of control of yellows.

Though many methods of curing peach-yellows have been exploited, no authentic case of a tree actually infected with this disease having been cured is recorded. The one effective method of handling diseased trees is to root them out with the least possible delay on the first indication of the trouble and burn them at once. When this plan of action is followed with absolutely rigid adherence to details, little need be feared from the encroachment of the disease. The entire tree must be destroyed. Cutting off the limb or limbs which show the first symptoms in the fruit ripening prematurely, avails nothing in the control of the trouble. Curiously enough, a young tree can be planted in the very place occupied by a yellows tree, immediately on the removal of the latter, if it happens to be during the proper time for planting peach trees, without more danger of its becoming infected than if it is planted elsewhere in the orchard.

Little-peach (*Cause unknown*)

This disease has been attracting more or less attention from peach-growers and fruit disease specialists for the past twenty-five years. It now occurs more or less generally in Michigan, New York, New Jersey, Delaware, Ontario,

Canada, and probably in other eastern and northern peach districts.

The cause and character of the disease are obscure as in the case of yellows and in many respects they appear to be closely related or similar to each other. Some of the symptoms, and in part the progress of the disease, are the same as in yellows. The means by which it is spread are likewise obscure.

Course of development.

The first evidence, which generally becomes apparent late in the season after the fruit is harvested, is a peculiar drooping of the leaves a short distance below the tips of the branches, those at the tip remaining normal. Under some conditions and in some stages, especially when the foliage alone shows the effects, it is difficult to distinguish this disease from yellows. If the trouble develops earlier in the season and the tree is in bearing, the fruit may be a little smaller and ripen slightly later than normal. This may develop first on a single limb as with yellows.

The second season these symptoms are intensified. The trouble involves more, perhaps all of the tree, in case only a single limb was affected the first year. The foliage characters are pronounced though the leaves near the tips of the branches may remain normal. The affected foliage is a lighter shade of green. All the fruit is decidedly smaller on the affected parts of the tree and is about ten days or two weeks later in ripening than normal for the variety, the flavor is poor and insipid, and the texture is stringy. The third and fourth years the foliage is very small, more or less scanty, the leaves at the tips are affected and in some varieties the outer third of each leaf turns back on itself.

The foliage is also a lighter green or even a yellowish green during the progress of the disease. The fruit is very much reduced in size and does not mature. Usually the fourth season there is but little fruit, and the tree develops a very weak, sickly appearance and generally begins to die, or may fail entirely before the end of the fourth year.

In individual trees and in different regions the rate of progress of the malady may vary more or less, some branches dying earlier than here indicated, but in general it usually requires about four seasons to complete the destruction of a tree if left to its natural course.

Methods of control of little-peach.

The same heroic measures described for yellows are equally effective in controlling this disease. No other known method of treatment is of any avail.

Peach-rosette (Cause unknown)

The cause of this disease is unknown but it has some characteristics in common with "yellows" and "little-peach" and probably belongs to the same general group of maladies. However, its progress is much more rapid and its climax much more quickly reached than is the case with either of these diseases. Rosette has existed more or less in certain sections of the South and possibly in some other parts of the country for many years, though it is now of rather rare occurrence and is attracting comparatively little attention.

Course of development.

The evidence of the presence of this disease is the development in early spring of "rosettes" of leaves from the leaf-

buds. This may occur first on a part of the tree as on a single branch, on several branches, or the entire tree may become affected at once. The rosettes consist of short branches two or three inches long, one of which grows from each bud, and a large number of small yellowish green leaves are borne on each branch thus making a sort of "tuft." If an entire tree is thus affected, it dies before growth begins the next season. If only a part of the branches are diseased the first season, those die before the opening of the second season. The remainder of the tree then develops the trouble the second season, dying in a corresponding period of time.

When a whole tree is affected at the same time, it does not mature fruit even if it sets. Healthy branches of an affected tree mature normally any fruit they may bear.

Means of control of rosette.

As with other diseases of this obscure group, the one known method of control is to dig up rosetted trees and burn them at the first symptom of the trouble. Otherwise it will spread to other trees.

Shot-hole, leaf-blight, leaf-spot

The plant pathologists recognize several different fungi as the causal agents of certain types of injury to peach foliage, the characteristic effects of which have given rise to the common names applied. It is not important, however, from the peach-grower's standpoint that he be able to distinguish these different fungi one from the other, since as far as known they do not require individual treatment for a good measure of control. They are more serious on other stone-fruits, especially the cherry and plum.

Course of development.

The affected leaves first show minute dark spots. These increase in size slightly, the diseased areas die and fall out, thus producing the "shot-hole" effect. The affected areas may run together more or less if they happen to occur near one another. The affected leaves gradually turn yellow, or otherwise cease to function and drop off.

Cherry and plum trees are often so badly defoliated in this way that it becomes a serious problem. The injury to peaches in well-cared-for orchards is not likely to be noticeable.

Methods of control of shot-hole.

But very little experimental work has been done in the control of these troubles. However, orchards that are properly sprayed for brown-rot and scab are not likely to suffer seriously from them.

Bacterial leaf-spot, bacterial shot-hole, bacteriosis, black-spot (Bacterium pruni)

These are all common names for the same disease, the terms being applied to different stages of the disease or to its appearance in different places. As is suggested by the names, the cause of the trouble is a bacterium. It is rather widely distributed east of the Mississippi River and occurs as far west as Kansas and Nebraska, but is more serious in some of the peach districts of the South than elsewhere, especially in neglected orchards.

Course of development.

This disease affects the leaves, twigs, and fruit, though it is perhaps most noticeable on the leaves. When much

dropping occurs, it is of course depleting to the vitality of the tree. Its development on twigs is confined to the current season's growth though the wounds thus produced may persist as perennial cankers.

Infections on the leaves first appear as small grayish specks, somewhat angular in form, and later become various shades of brown. Individual infections may run together.

Infected areas appear on the twigs as black cankers in early spring or more often not until May or June. The first indication of infection is a minute spot having a water-soaked appearance. As the spot enlarges, it elongates and may extend half-way around the twig or even more. By the second year these areas largely disappear but the cankers carry the disease over winter and become sources of infection the next season.

Infections on the fruit appear as a rule while the fruit is still very small, as minute gray specks just beneath the outer skin. As these areas develop the skin cracks slightly and where infected areas are numerous the cracks run together making a network of lines. Considerable difference exists in the susceptibility of varieties.

Methods of control of leaf-spot.

Rolfs [1] found that bordeaux mixture would control the disease but its use on peach leaves is prohibited by the injury which it causes to them. Self-boiled lime-sulfur mixture is less effective though its efficiency appears to be increased by adding to it arsenate of lead at the rate of 2 pounds to 50 gallons. The poison probably controls insects which might otherwise cause new infections.

[1] Memoir No. 8, Cornell Univ. Expt. Sta. "A Bacterial Disease of Stone Fruits."

Apparently, however, much can be accomplished in its control by good orchard management. Rolfs makes it clear that trees on which the foliage is thrifty and vigorous are resistant in a high degree as compared with those that are less well maintained. Roberts[1] also indicates that in southern orchards trees maintained in a high state of cultivation are commercially immune to this disease.

Powdery-mildew (Sphærotheca pannosa)

This disease though widely disseminated is rarely of serious economic importance.

Course of development.

Powdery-mildew develops usually in the early part of the season, attacking the foliage near the ends of the branches, the young tender twig growth, and sometimes the fruit. The presence of the disease gives a white frosted appearance to the affected parts. As only the young leaves and tips are affected so far as the tree is involved, serious damage rarely occurs. If the fruit is attacked when small, it is likely to drop before it matures. It sometimes occurs on trees in the nursery, causing the death of the young tender growing tips of the twigs. This may prevent the trees from developing into high-grade stock.

Methods of control.

But little attention has been given to the control of powdery-mildew. Since it thrives best in warm, moist, shaded locations, keeping the tops of the trees well pruned so as to admit sunshine and air and thus promote the

[1] U. S. Dept. of Agr. Bull. 543.

rapid drying of dews and rains is doubtless advantageous. Moreover, the mildews that occur on other hosts usually yield quickly to sulfur sprays. Peach trees which are well sprayed for the more serious diseases will rarely require separate treatment to control the mildew. Should it become threatening at any time, it is probable that the self-boiled lime-sulfur mixture or flowers of sulfur in water would be effective.

Frosty-mildew (Cercosporella persicæ)

This disease apparently occurs more frequently from the central Atlantic states southward than in other peach regions. However, it is not of special concern even in those regions where it is most prevalent.

The conditions described as favorable for powdery-mildew are likewise favorable for this disease.

Course of development.

An area of infection appears on the upper surface of a leaf as a pale yellowish spot, while the corresponding area on the other side develops a delicate, frost-like growth which consists of the fruiting bodies.

Methods of control.

Though little experimental work looking to the control of this mildew has been done, as there is rarely any necessity for specific action to that end, it is probable that the treatment suggested for powdery-mildew would prove effective.

Rust (Puccinia spinosæ)

This disease is very widespread and has as its hosts practically all stone-fruits, besides some wild herbaceous plants.

Though not serious economically, it sometimes causes some loss of foliage of peach and other stone-fruits, especially in the South and Southwest.

Course of development of rust.

Peach rust occurs principally on the foliage towards autumn though appearing to some extent in midsummer. The fruit is rarely affected. On the lower surfaces of the leaves the disease appears in the form of minute pustules, light brown in color and filled with a powdery substance — the spores. Later the pustules turn dark brown or nearly black. Where the leaves become badly affected they drop, but as stated this rarely happens to a serious extent.

Methods of control.

As a group of diseases, the rusts are difficult to control by spraying, though it has been suggested that the spraying program advised for leaf-curl would probably help materially in controlling this disease when it becomes necessary to take action. Because of the peculiar progress in the steps in the life cycle of this rust, the presence of the wild anemone, hepatica, and one or two other common wild flowers is necessary to its perpetuation on stone-fruits, one stage of the disease developing only on those plants. In their absence, the life cycle is broken and the disease cannot perpetuate itself.

California peach-blight or coryneum-blight (Coryneum beijerinkii)

As the name suggests, this disease is of particular economic importance in California. It is in that state, at least, that it has attracted special attention.

Course of development.

As described by Smith[1] and his associates in referring to a serious outbreak of this disease: "The trouble consisted in the dying of the buds on the fruiting wood, spotting of the green twigs, and dropping or non-development of the young leaves and fruit. Particularly noticeable, and the most prominent feature of the disease, was a copious 'gumming' or exudation of masses of gelatinous sap from the twigs, originating in the dead spots and buds. This gumming was extremely abundant in wet weather all over the one-year-old fruiting twigs of affected trees, and with the blighted leaves and fruit and spotted, leafless, dead or dying twigs and shoots, gave the tree a most distressing and alarming appearance. The crop was entirely ruined in badly affected orchards and the trees brought into an extremely weakened condition."

Under California conditions, particularly in the valleys where this disease has at times prevailed to a serious extent, most of the infection takes place during the winter. Twigs that appeared healthy in December may show definite infection by the first of February.

Methods of control of blight.

Experience has demonstrated that this disease can be completely controlled by spraying with bordeaux mixture. A single thorough application made any time during the period from about the first of November to the middle of December appears to be effective. If the application is delayed until later than December, it is correspondingly less effective. Applications later than the first of February have little or no controlling effect on the disease.

[1] Cal. Expt. Sta. Bull. 191.

It has been observed that leaf-curl, which is sometimes serious in California, as it is throughout the entire country, appears to be largely controlled also by a November or December application of bordeaux mixture. Where leaf-curl is extremely bad, however, it is not so completely controlled by a late fall application as by a spraying in February or March.

It seems probable that the lime-sulfur mixture used at dormant-spray strength would be equally effective in controlling these diseases and at the same time control San José scale.

As the peach twig-borer or peach-worm (*Anarisa lineatella*) is also controlled (see page 233) by lime-sulfur applied just as the buds are opening, the best spraying program where these three troubles occur is to apply bordeaux mixture during November or the first half of December for blight and for a measurable control of leaf-curl; again just as the buds are beginning to swell for the peach-worm (or twig-borer) and the final control of leaf-curl and also for the San José scale when that occurs.

Crown-gall (*Bacterium tumefaciens*)

This is a bacterial disease common to various tree-fruits, also to raspberries, blackberries, and other plants. Probably the greatest economic importance of crown-gall on peach trees is as a disease of nursery stock, since it is during the nursery period that they are most likely to become affected, and this stock probably constitutes the chief means of dissemination.

PLATE XXII. — AFTER-RESULTS OF DEHEADING. *Left*, limbs cut back into wood which was too old, some of the stubs failing to make new growth; *right*, a vigorous tree which has been deheaded three times.

Course of development.

The presence of this disease is indicated by the development of warty excrescences on the larger roots and particularly at the crown of the tree just below the surface of the ground. These excrescences are more or less spherical in shape, and in size vary from bodies so small as to be unnoticed to so large that they involve nearly the whole of a main root at the point where a gall develops.

The effect of crown-gall is in proportion to the extent to which the roots are involved. If in a serious degree the normal functions of the roots are interfered with and the tree becomes weak and unthrifty, the foliage is light colored — the tree looks "sick." These evidences become more and more acute until the tree finally dies.

Means of control of crown-gall.

The only method of control is by preventive measures. There is no cure, once a tree is infected. All nursery stock should be examined very critically before it is planted in order to detect every indication of small galls just beginning to form. Every tree that shows any evidence of them should be burned. If a gall is discovered where it can be cut off, its removal might delay somewhat the progress of the trouble, but a tree so handled would remain under suspicion and galls would be likely to develop subsequently.

When crown-gall is discovered on a tree that has been planted some years, the ultimate weakening therefrom may be deferred somewhat by keeping the soil well enriched, especially with nitrogenous plant-foods, thus providing as favorable conditions as possible for tree growth.

Die-back (Valsa leucostoma)

The economic importance of this disease was apparently first fully recognized in the United States by Rolfs,[1] who in 1910 published the results of his studies. The occurrence of the disease has been reported from many widely separated points, and its distribution may be regarded as general throughout the peach-producing sections of the country. However, it is rather definitely associated with the depleted vitality of neglected orchards.

Course of development.

In general the trouble begins with the appearance on the twigs of small roughened or cankered spots which center about the buds. Frequently, following an infection of the twigs, the fungus works its way into large branches and limbs, killing them one by one until the whole tree dies. Sometimes the branches are girdled by the disease. The progress of the malady varies more or less, however, being governed evidently by the condition of the tree, climatic conditions, and other influences. Doubtless many cases of injury from this disease have been looked on as "sun-scald," "winter-injury," and the like.

Methods of control.

Rolfs points out that any methods of orchard management which are conducive to the health and vigor of the trees serve as preventive measures, since it is weakened or unthrifty trees that are most severely attacked. Three applications of weak bordeaux mixture in the fall and one application of normal strength in the spring greatly reduced

[1] Mo. State Fruit Expt. Sta. Bull. 17.

the disease, in Rolfs' experience, but apparently little is to be feared from it in orchards that receive good cultural attention.

Root-rot

This term is used in a rather broad sense and is applied to several distinct fungous diseases which attack the roots of peach and other trees, causing them to decay, and resulting in the death of trees so affected. These diseases all develop under much the same conditions. The loss from them aggregates a large amount in some sections.

Course of development.

It often happens that the grower is unaware of serious trouble with any of his trees until he discovers one or several that appear "sick"; the foliage may be wilting; the early death of the tree is perhaps apparent.

On examination, it may be found that the tree can be tipped over easily and that the roots, save perhaps one or two, are dead and decaying. Or if the tree still stands firmly in its position, it may be that the disease has girdled the trunk at, or just below, the surface of the ground and the bark there is dead. Sometimes, also, a tree dies because the disease has destroyed the power of the roots to function, even though they may not have decayed when the tree dies. Whichever one of the various fungi may be at work, the results are usually the same — the death of the tree.

Not infrequently there is particularly heavy loss from this type of disease where an orchard is planted on recently cleared land which contains many decaying roots of forest trees.

Methods of control of root-rot.

Usually the disease has progressed so far when discovered that little or nothing of material value can be done to save an affected tree. A method reported from Oregon consists in removing most of the soil early in the season from the area occupied by diseased roots, cutting off those that are affected and cleaning away diseased bark at the crown. After disinfecting the wounds, the parts are left exposed to the air for a considerable length of time. This "aëration method," as it is called, is said to offer some promise.

When a single tree here and there in an orchard is affected, the "trenching method" has been suggested. This consists in digging a trench a foot wide and two feet or more deep and at a sufficient radius from the tree to leave all the diseased roots on the side of the trench next the tree. The soil from the trench should be thrown towards the tree. This results merely in isolating the diseased tree from its neighbors, which are presupposed to be uninfected when this method is used, the disease spreading gradually through the soil if not restricted.

The various diseases causing root-rot may live for a long time as saprophytes on dead parts of roots or other pieces of wood that may be in the soil. Therefore, after the removal of a diseased tree, the place should not be filled by replanting another.

Gummosis

Gummosis is a rather general term applied to a group of troubles the evidence of which is the exudation of gum from points on the trunk, branches, or twigs. It commonly occurs in the spring, the gum forming in globules which vary in size. At first they are soft, then amber-colored,

glossy, transparent, and hard. Later, in the presence of much rain, the gum masses may swell and become sticky and gelatinous in appearance. Hesler and Whetzel [1] enumerate nearly twenty primary causes of gumming or gummosis, including several fungous diseases, one or more bacterial diseases, injuries due to insects and other mechanical means, physiological troubles resulting from unfavorable soil or climatic conditions, and others. The phenomenon of gumming is, therefore, an expression usually of some disorder rather than being itself a primary cause. However, wounds do not always exude gum and it is believed by some authorities that there is an exciting or stimulating influence in some cases apart from the wound itself that induces the exudation of gum. An enzyme is commonly held by such authorities to be the inciting cause of the exudate.

Methods of control.

It is obvious when a phenomenon may result from so large a number of causes that the first step in control is to determine the causal agent of the condition and then remove the cause or condition or apply such remedy as may be suggested by circumstances.

Little-leaf, or California yellows

The cause of this trouble appears to be a physiological disturbance due to unfavorable soil conditions, particularly with regard to moisture. It has no relation to "peach-yellows" of the East.

[1] "Manual of Fruit Diseases."

Course of development of little-leaf.

As described by Smith and Smith [1] the development of the trouble is substantially as follows: "Little-leaf" is characterized by the development of spindling, yellow, sickly looking shoots on the new growth, with small, narrow, yellow leaves. The leaves along the shoots drop off during the summer, leaving tufts at the ends. The fruit fails to develop, shrivels and drops, and is worse on trees from three to seven years old, and on the lighter, drier soils, this feature showing itself by the more pronounced occurrence of the disease on trees standing in sandy streaks or slight elevations in the orchard. Therefore, as might be expected, it occurs mostly following unusually dry seasons, on trees standing in light soil or one underlaid with a coarse, sandy subsoil. Trees on a fairly heavy subsoil, or those which have received abundant irrigation throughout the preceding season, are mostly or entirely free from the trouble even in the worst affected localities.

Methods of control.

In most cases, regular irrigation during the summer shows a marked effect in controlling this trouble. Such irrigation should be given particularly in the latter part of the season, after the crop is off, and especially when the rains are late in commencing.

Other diseases

While other diseases besides these discussed may occur locally, or even widely disseminated, they are of little economic importance in most cases or are controlled by the

[1] Cal. Exp. Sta. Bull. 218.

spraying program arranged for the major diseases. At the same time, the grower should always be on the watch for an outbreak of some new or little-known disease, and in case he discovers anything that arouses his suspicions, he should take steps to ascertain whether or not it is a serious peach menace.

INSECTICIDES, FUNGICIDES, SPRAYING

The following paragraphs are presented for the purpose of aiding the grower as far as possible in making and using the various preparations which have been found the most effective in controlling the more common peach insects and diseases.

The grower should keep clearly in mind the important fact that successful spraying of fruit-trees is absolutely dependent on three factors: (1) The proper spraying material; (2) timely applications; (3) and thoroughness of application. To fail in any one of these particulars is equivalent to failing in all of them.

Insecticides

Concentrated lime-sulfur mixture.

This preparation kills by contact with the insect. It is used when the trees are dormant and principally for scale insects. Reference to its use as a fungicide occurs under "leaf-curl" on page 259. It has been tried also in a much diluted form as a summer spray for the control of brown-rot and scab, but experience has shown that it is unsatisfactory, since in a strength sufficient to control these diseases there is great danger of injury to the foliage.

There are numerous commercial brands of concentrated lime-sulfur on the market. Many growers prefer to use one of them and if only a small amount of spraying is to be done it is probably more satisfactory to do so than to prepare a homemade mixture. Where large operations are involved, however, considerable expense is doubtless saved by the grower making it himself.

The equipment necessary to prepare the homemade mixture, unless on a large scale, is comparatively simple. A 75-gallon kettle and a 50- to 75-gallon water tank so set in masonry or brickwork as to provide a fireplace beneath comprise the essential features.

In large scale operations a more elaborate system of tanks and equipment for cooking the mixture by steam is advisable. Such an equipment is shown in Plate XXIV, where the barrels in which the cooking is done appear in the back on the upper level of the "spray house." Cooking is commonly done by steam, coils of pipe being placed in the barrels or tanks and connected with a boiler. The ingredients pass by gravity from one container to another when they are brought together. The large containers on the lower platform to which pieces of hose are attached hold the spray mixtures that are ready for use.

The directions for preparing and handling homemade lime-sulfur mixture as given by Quaintance [1] are as follows:

"Stone lime	pounds	20
Sulfur (flour or flowers)	do	15
Water to make	gallons	50

"Heat in a cooking barrel or vessel about one-third of the total quantity of water required. When the water is hot

[1] Farmers' Bull. 650.

add all the lime and at once add all the sulfur, which previously should have been made into a thick paste with water. After the lime has slaked, about another third of the water should be added, preferably hot, and the cooking should be continued for one hour, when the final dilution may be made, using either hot or cold water, as is most convenient. The boiling due to the slaking of the lime thoroughly mixes the ingredients at the start, but subsequent stirring is necessary if the wash is cooked by direct heat in kettles. If cooked by steam, no stirring will be necessary. After the wash has been prepared, it must be well strained as it is being run into the spray tank. It may be cooked in large kettles, or preferably by steam in barrels or tanks. This wash should be applied promptly after preparation, since, as made by this formula, there is crystallization of the sulfur and hardening of the sediment upon cooling. Probably comparatively few fruit-growers at the present time prepare the wash according to this old method, but employ the commercial or homemade concentrate.

"The inconvenience experienced in preparing the lime-sulfur wash according to the foregoing formula by cooking with steam or in open kettles at home has been one of the principal objections to this spray. Manufacturers have, therefore, put on the market concentrated solutions of lime-sulfur which have only to be diluted with water for use. These commercial washes, if used at proper strength, have proved to be quite as satisfactory in controlling the scale as the old-formula lime-sulfur wash, and, although somewhat more expensive, have been adopted by many of the commercial orchardists in preference to the "20–15–50" formula. They are especially useful for the smaller orchard-

ists whose interests do not warrant the construction of a cooking plant."

When a grower uses one of the commercial brands of lime-sulfur, he should follow directions supplied by the manufacturer in applying it.

Miscible oils.

These are essentially petroleum oils that have been so treated that they will emulsify with water. They are proprietary preparations and should be used in accordance with the nature and strength of the different brands. They have been much employed in the past in spraying for San José scale and they are also used successfully in controlling the peach-lecanium or terrapin-scale. Under some conditions they may be more convenient to use as a dormant scale-spray than the lime-sulfur mixtures.

Tobacco extracts.

As indicated under the discussion of the "black" and the "green" aphids, preparations made by extracting the nicotine from tobacco stems and other tobacco refuse are very effective in controlling these soft-bodied insects. Several commercial brands of such preparations are on the market. Of these preparations and their use Quaintance[1] speaks as follows:

"Aphids are killed by surprisingly small quantities of nicotine in water, and because of the entire safety with which it can be applied to plants nicotine is better suited than other sprays to control these insects [aphids or plant-lice]; while the cost of the concentrated article is high, the extent to which it may be diluted makes the spray compare

[1] Farmers' Bull. 804.

favorably in cost with other contact sprays. Nicotine is extracted from refuse tobacco, principally stems, by different commercial concerns, and is put on the market in several grades and strengths. The 40 per cent nicotine sulfate is the solution principally used, although weaker grades of nicotine may be employed provided care is taken that the spray be made so as to contain not less than 0.05 or 0.06 per cent of actual nicotine.

"Nicotine may be added either to the winter-strength lime-sulfur solution for the San José scale or to the dilute lime-sulfur solution and arsenate of lead spray employed in the control of insects and diseases of fruit and foliage. It may also be used in bordeaux mixture and arsenate of lead spray without interfering with its effectiveness, or in an arsenate of lead, milk of lime, and water spray. In orchard spraying the 40 per cent nicotine sulfate is used at the rate of about $\frac{3}{4}$ pint to 100 gallons of water, lime-sulfur solution, or bordeaux mixture. When used in water the addition of soap at the rate of 4 or 5 pounds to 100 gallons adds much to its spreading power and efficiency. Soap should not be used with lime-sulfur solution, but may be used in bordeaux mixture. Where only a small quantity of spray is required, the nicotine sulfate may be used at the rate of 1 teaspoonful to a gallon, or 1 ounce to 8 gallons of soapy water."

Linseed oil emulsion.

This preparation is reported by Simanton[1] as being one of the most effective of a considerable number tested in controlling the terrapin-scale or peach-lecanium. It is composed as follows:

[1] U. S. Dept. of Agr. Bull. 351.

Raw linseed oil	5 gallons
Gasoline	3 gallons
Laundry soap	2 pounds
Water	92 gallons

According to the above authority — "The best way of preparing this spray is by mixing 5 gallons of raw linseed oil and 3 gallons of gasoline and then adding 2 pounds of soap dissolved in 4 gallons of hot water. The whole is churned for 5 minutes through a spray pump, then diluted to double its volume and churned again for 1 minute, after which it should be diluted to 100 gallons, when it is ready to use."

One thorough application made in the spring before the buds burst has been found an effective means of controlling the terrapin-scale.

Arsenate of lead.

This is the poison now used for biting and chewing insects almost to the exclusion of all others. Its most important use in spraying peaches is for the control of the curculio. For this insect it is nearly always used in combination with a fungicide — quite habitually the self-boiled lime-sulfur mixture — and at the rate of 2 pounds to 50 gallons of the mixture, or of water, if applied without a fungicide. When water is used as the conveyor, stone lime freshly slaked should be added at the rate of 2 to 3 pounds to every 2 pounds of the poison in order to prevent injury to the foliage.

The grower will not find it practicable to prepare this poison himself, but he should purchase one of the well-tried commercial brands, of which there are many in both powder and paste form.

Fungicides

Self-boiled lime-sulfur mixture.

By far the most important fungicide for the peach-grower is the self-boiled lime-sulfur mixture. Its great importance is that it will control in a high degree the two most destructive fungous diseases of the peach — brown-rot and scab — and can be used if properly made without injury to the foliage. Though of value primarily as a fungicide, when used on trees that are infested with the San José scale it has been found that the applications are of considerable importance in killing the young before they begin to secrete the protective scale covering.

Directions for preparing the self-boiled lime-sulfur mixture as given by W. M. Scott,[1] who first worked out this preparation as a fungicide for use on peaches, are as follows:

"The standard self-boiled lime-sulfur mixture is composed of 8 pounds of fresh stone lime and 8 pounds of sulfur to 50 gallons of water. In mild cases of brown-rot and scab a weaker mixture containing 6 pounds of each ingredient to 50 gallons of water may be used with satisfactory results. The materials cost so little, however, that one should not economize in this direction where a valuable fruit crop is at stake. Any finely powdered sulfur (flowers, flour, or "commercial ground" sulfur) may be used in the preparation of the mixture.

"In order to secure the best action from the lime, the mixture should be prepared in rather large quantities, at least enough for 200 gallons of spray, using 32 pounds of lime and 32 pounds of sulfur. The lime should be placed in a barrel and enough water (about 6 gallons) poured on

[1] Farmers' Bull. 440.

to almost cover it. As soon as the lime begins to slake the sulfur should be added, after first running it through a sieve to break up the lumps, if any are present. The mixture should be constantly stirred and more water (3 or 4 gallons) added as needed to form at first a thick paste and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as it is well slaked water should be added to cool the mixture and prevent further cooking. It is then ready to be strained into the spray tank, diluted, and applied.

"The stage at which cold water should be poured on to stop the cooking varies with different limes. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking, and care must be taken not to allow the boiling to proceed too far. If the mixture is allowed to remain hot for 15 or 20 minutes after the slaking is completed, the sulfur gradually goes into solution, combining with the lime to form sulfids, which are injurious to peach foliage. It is therefore very important, especially with hot lime, to cool the mixture quickly by adding a few buckets of water as soon as the lumps of lime have slaked down. The intense heat, violent boiling, and constant stirring result in a uniform mixture of finely divided sulfur and lime, with only a very small percentage of the sulfur in solution. It should be strained to take out the coarse particles of lime, but the sulfur should be carefully worked through the strainer."

The caution that these directions be followed with extreme fidelity and care cannot be made too emphatic. This applies in all particulars, but especially in the matter of overcooking the mixture by allowing it to stand too long before

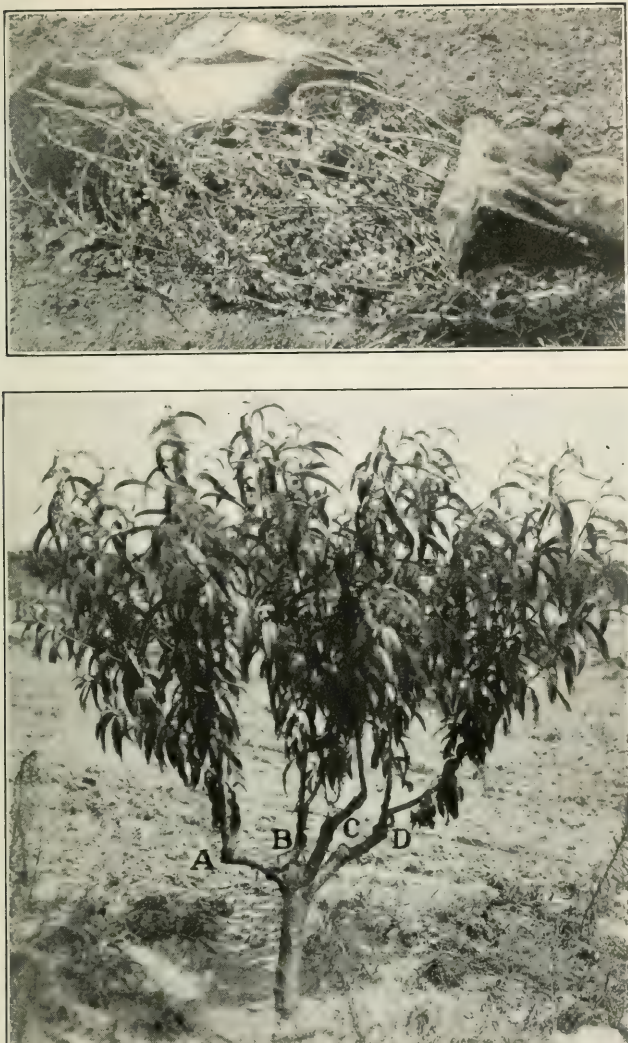

PLATE XXIII. — *Top*, a peach tree laid down during the winter and covered for protection, now being gradually uncovered in spring; *bottom*, renewal by top-budding, buds inserted at *A*, *B*, *C*, and *D*.

adding water as directed. To disregard this feature will usually mean injury to the foliage in proportion to the extent of the departure from directions.

Atomic sulfur.

This is a proprietary name for a commercial form of sulfur that is exceedingly finely divided. It has been recommended and used to a limited extent in place of the self-boiled lime-sulfur mixture. While the results, on the whole, have been fairly satisfactory, this form of sulfur does not stick as well as the self-boiled lime-sulfur mixture, and it is not as effective in controlling brown-rot and scab. Under some conditions, however, it may be advisable to use it. As a substitute for self-boiled lime-sulfur, it is applied at the rate of 5 pounds to 50 gallons of water. It seems probable that this material would be successful also in controlling the various mildews.

Bordeaux mixture.

It has been noted previously that this old and much-used fungicide has never been of much service to the peach-grower in controlling diseases of the fruit because it burned the peach foliage so badly. With the development of the sulfur sprays, it is now of even less value in most respects than formerly, when peaches are concerned. Its use as a dormant spray, however, has been mentioned, particularly in connection with the California peach-blight or Coryneum-blight (page 270). For this purpose the 4–4–50 formula is recommended.

The method of preparing this mixture is doubtless too familiar to every fruit-grower to require extended description here. Briefly stated the procedure is as follows:

Dissolve 4 pounds of bluestone (copper sulfate) in a small quantity of water and dilute to 25 gallons. Slake 4 pounds of lime and dilute with 25 gallons of water, thus using the required 50 gallons of water. Next, let the bluestone solution and the lime mixture pass into a third vessel, the two coming together as they enter. The vessels in which the two ingredients are held may be connected with the third by spouts and the liquids brought together as they run into it or they may be dipped with pail or bucket and poured into the third container, a pail of each passing in at the same time. A better mixture results from this method than when one is poured directly into the other.

If a considerable quantity is to be made, it is not necessary to dilute the lime and bluestone solutions each with one-half the total quantity of water ultimately required; the solutions should be diluted considerably, however, before they are brought together, and the full dilution made when the mixture is used. Concentrated stock solutions of bluestone and lime may be made in quantity and held separately until desired for use.

Other insecticides and fungicides.

There are other spray mixtures variously recommended for the control of peach insects and diseases. Many of them are proprietary preparations and may have their field of usefulness. The above named insecticides and fungicides, however, have the approval of peach-growers of long experience as well as that of investigators. They may be regarded, therefore, as the standards by which other preparations should be judged.

Spraying

As important as are suitable insecticides and fungicides in the control of peach insects and diseases, they are without avail unless properly applied. Perhaps the most common fault is lack of thoroughness. Many growers have virtually thrown away time and money because the trees were not sufficiently well covered with the spray mixture to accomplish the end in view. For instance, the San José scale may infest every part of the surface of a tree, excepting, in case of an old tree, the portion of the trunk and larger limbs where the bark is rough and hard. The sprays used in its control kill only by contact and have absolutely no effect on any insects on a sprayed tree which they do not hit. Again, spraying to control brown-rot or scab is a preventive, not a curative, measure. Any portion of the surface of a fruit not kept completely covered with a thin film of the fungicide is subject to attack. The fungicide on one side of a peach will not give protection against infection on the other side. For obvious reasons, the spores from which these diseases develop are more likely to fall on the upper than on the under surfaces of the fruits.

To spray thoroughly does not mean the drenching of a tree until the spray mixture is dripping from the branches. Such spraying is wasteful, since what drips off is lost and serves no useful purpose. Thorough spraying means the complete covering with a thin film of the spray mixture of every portion of the surface of the tree, foliage, and fruit, depending on the time when, and the object for which, the spraying is being done, It is of course obvious that in the practical application of spray mixtures in orchard work there will

be inevitably some loss from dripping. It can hardly be otherwise, but ideal spraying permits of only a minimum of dripping. Timeliness is of no less importance than thoroughness. The proper preparation applied thoroughly and at the right time gives success in spraying. With fault in any of these particulars the result will be failure in proportion to the degree of the fault.

Perhaps the most satisfactory spraying program applicable generally throughout peach-growing regions for the principal insects and diseases that require treatment during the period of active tree growth is the one offered by Scott and Quaintance,[1] which is as follows:

Schedule of applications.

"Most of the peach orchards in the eastern half of the United States should be given the combined treatment for brown-rot, scab, and curculio. This is particularly true of the southern orchards, where all these troubles are prevalent. In some of the more northern orchards the curculio is not very troublesome, but as a rule it will probably pay to add the arsenate of lead in at least the first lime-sulfur application.

"The self-boiled lime-sulfur mixture referred to in the following outlines of treatment should be made of a strength of 8 pounds of lime and 8 pounds of sulfur to each 50 gallons of water, and the arsenate of lead should be used at the rate of 2 pounds to each 50 gallons of the mixture or of water. When the poison is used in water, there should be added the milk of lime made from slaking 2 to 3 pounds of good stone lime. When used in the lime-sulfur mixture additional lime will not be necessary.

[1] Farmers' Bull. 440.

"*Midseason varieties.*

"The midseason varieties of peaches, such as Reeves, Belle, Early Crawford, Elberta, Late Crawford, Chairs, Fox, and Beers Smock, should be sprayed as follows: (1) with arsenate of lead alone, about 10 days after the petals fall, or at the time the calyxes are shedding; (2) with self-boiled lime-sulfur and arsenate of lead, two weeks later, or four to five weeks after the petals have been shed; (3) with self-boiled lime-sulfur alone, four to five weeks before the fruit ripens.

"*Late varieties.*

"The Salway, Heath, Bilyeu, and varieties with a similar ripening period should be given the same treatment prescribed for midseason varieties, with an additional treatment of self-boiled lime-sulfur alone, to be applied three or four weeks after the second application.

"*Early varieties.*

"The Greensboro, Carman, Hiley, Mountain Rose, and varieties having the same ripening period should receive the first and second applications prescribed for midseason varieties.

"Where the curculio is not particularly bad, as in Connecticut, western New York, and Michigan, the first treatment, which is for this insect only, may be omitted. Also for numerous orchards throughout the middle states where the insect, especially in the younger orchards, is not yet very troublesome, orchardists should use their judgment as to whether the first application may be safely omitted. Where peach-scab is the chief trouble, and brown-rot and curculio are of only minor importance, as may be the case in some of

the Allegheny Mountain districts, satisfactory results may be had from two applications, namely, the first with self-boiled lime-sulfur and arsenate of lead four to five weeks after the petals fall, and the second treatment of the above schedule with self-boiled lime-sulfur alone three to four weeks later. These two treatments, if thoroughly applied, will control the scab and brown-rot, especially on the early and midseason varieties, and will materially reduce curculio injuries. Even one application of the combined spray made about five weeks after the petals fall would pay well, although this is recommended only for conditions where it is not feasible to do more."

Spraying equipment.

It is unnecessary in this connection to consider spraying equipment at any length. The peach-grower with spraying to do has only two alternatives in the choice of equipment so far as type of apparatus is concerned. If his orchard is small, he can get along with a hand barrel-pump. If more extensive, a power-sprayer is a practical necessity. Where the dividing line between the two types of equipment falls, as expressed in acres or in economy of operation, cannot be stated arbitrarily. The relative cost, availability of labor, and other local factors all enter into the consideration.

If a hand pump is used, a single "lead" of hose only will be required, but with a power sprayer at least two lines are generally used. In either case the lines of hose should be 25 to 35 feet in length and an extension rod 6 or 8 feet long or a spray-gun will usually be advantageous; also nozzles that will throw a very fine spray. While trees that are pruned to low heads can usually be reached fairly well from the ground

by the men who handle the spray rods, yet in many cases better work can be done and a more thorough application made if the one handling the hose (or one of the men in case two leads of hose are being used) is somewhat elevated. If a barrel pump is carried in an ordinary farm wagon, as is commonly done, the wagon may be all that is necessary to raise the nozzle to a sufficient length. If a power-sprayer is used, some form of low tower erected over the sprayer or perhaps the top of the tank will serve the purpose adequately.

Dusting peaches to control insects and diseases

During the past few years considerable effort has been made to work out a method whereby insecticides and fungicides may be applied in the form of dust rather than in liquid. The work is still in an experimental stage, but promising results have been secured by several different investigators.

The preparation that has given the most hopeful results on peaches consists of superfinely ground sulfur, a very finely powdered arsenate of lead, and an equally finely powdered conveyor — commonly hydrated lime. In some cases, however, the sulfur and arsenate of lead have been used together without dilution. In the latter case a mixture either of 90 parts sulfur and 10 parts arsenate of lead, or 95 of the former and 5 of the latter, has been used. Chase[1] found the latter strength preferable to the stronger mixture for peaches. He also used a "sulfur-arsenate of lead-lime" mixture made up of 45, 5, and 50 parts respectively of these ingredients, and another of 60, 5, and 35 parts

[1] Ga. State Bd. of Ent. Circ. 21.

respectively, both of which gave good results in controlling curculio, scab, and brown-rot.

The dusting is done with a machine designed for the purpose of which there are several different makes obtainable, including machines worked by hand and others operated by horse-power. The schedule of applications, so far as determined, is substantially the same as for the liquid sprays (see page 290).

Some of the assertions made for dusting in preference to spraying are: ease of application; saving of labor; uniformity of distribution and the very close adhesion of the dust to the leaves and fruit; saving in cost of equipment; elimination of water and hence great reduction in weight of material that has to be hauled through the orchard, and consequently the ability to operate in the spring at times when the soil conditions do not permit the use of a heavy spray-rig; and finally a high degree of efficiency in the control of curculio, scab, and brown-rot and the excellent color which commonly characterizes the fruit treated by this method.

On the other hand, dusting, in the present degree of perfection of the method, is commonly followed by some burning of the leaves, which may result in the defoliation of the trees, and by injury to a material percentage of the fruit due to the cracking of the skin. These forms of injury are likely to occur if too heavy applications have been made, and especially if followed closely by rain. These difficulties do not appear insurmountable; and it seems likely that in due course a fungicide-insecticide dust mixture will be compounded that will be effective on peaches in controlling curculio, scab, and brown-rot and still not possess the faults of those that have thus far been used.

CHAPTER XII

THINNING THE FRUIT

The general tendency from man's standpoint is for peach trees to overbear. From nature's standpoint the ultimate function of the tree is to reproduce its kind, which left to itself it does through the abundance of the seeds that it matures. In this respect nature is frequently lavish in the extreme. She is concerned with numbers only, while man has learned in his experience with peach trees that there is incompatibility between numbers and the size of the fruit which best suits his purpose.

This experience may be said to be universal. There is perhaps no other operation concerning the desirability of which there is a more complete oneness of opinion among peach-growers than in regard to thinning when the trees are overloaded. There may not be the same accord in all cases with regard to practice nor concerning the amount of fruit a tree ought to be allowed to bear. These points, however, admit of no arbitrary settlement. There is some difference in varieties and in trees of the same variety differing in strength and vigor with regard to the amount of fruit they should carry.

In the chapter on pruning the significance of the position of the fruit-buds with reference to some features of that operation was pointed out; also the relation to it of certain

differences in varieties in habit of growth, particularly with regard to the formation along the branches and in the interior of the tree of short annual twigs which amount almost to fruit-spurs. These different characteristics have a similar significance from a variety standpoint with regard to thinning. This is of course to be expected, since one of the stated objects of pruning is to thin the fruit. Obviously varieties which form their fruit-buds singly (Plate XV) do not as a rule require so much thinning as do those which form them in doubles — one on each side of a leaf-bud (Plate XV). The relation of the short spur-like growth to thinning is in proportion to the amount of such growth that is developed. In some cases it materially increases the amount of bearing surface, therefore the amount of thinning that may need to be done.

Thinning overloaded trees operates in various ways, the more important of which are as follows: On the present crop (1) it increases the size of the fruit; (2) improves the color; (3) improves the flavor; (4) increases the uniformity of ripening; (5) decreases the labor in picking and packing. On the tree (6) it prevents undue depletion of vitality; (7) because of "6" it may have an important relation to the next season's crop, also to winter injury; (8) prevents breakage of limbs.

To the experienced peach-grower these results are self-evident, but a brief amplification of the several features mentioned will serve to fix their importance.

1. Walker [1] illustrates Elberta peaches from a moderately thinned tree of which 140 to 180 made a bushel, and in contrast, peaches from an unthinned tree of which it required 260 to 272 for a bushel. Starcher [2] speaks of a crate which

[1] Ark. Expt. Sta. Bull. 79. [2] Va. Poly. Inst. Ext. Bull. 1.

he saw packed with 90 extra fancy peaches, and another crate of the same size packed with 228 small peaches of the same variety. The latter crate took nearly three times as long to pick, grade, and pack as the first crate. Baskets, crates, hauling, and freight cost the same for each package. The price received for the first was \$3, while the second brought less than one-half as much. The first crate gave a net profit of about \$2, while for the second the profit was scarcely 50 cents. The trees on which the first lot grew had a strong set of fruit-buds for the next season's crop; the trees on which the second lot grew were scarcely able to keep alive.

The New Jersey Experiment Station[1] presents the same truth in another way: In one instance 70 per cent of the peaches were removed from some trees in thinning; from another lot 32 per cent (supposedly trees in both cases that were bearing like quantities in the beginning). At harvest time, 2.8 baskets of fruit to a tree, each fruit averaging 4.48 ounces, were gathered from the heavily thinned lot, and which sold for \$1 a basket, or \$2.80 a tree. From the less heavily thinned lot, 3.9 baskets of fruit to a tree were harvested, each fruit averaging 2.8 ounces, and which sold for 45 cents a basket, or \$1.75½ a tree.

Though the lightly thinned tree produced in bulk about 25 per cent more fruit than the heavily thinned, the individual fruits were more than 50 per cent heavier and sold for more than double the price received for the smaller fruit, resulting at the prices given in a financial gain for the heavier thinning of more than \$1.00 a tree, not taking into account the cost of thinning. There was a saving in the heavy thinning because there were fewer fruits to handle at packing time and fewer crates were necessary to contain the fruit.

[1] An. Rept. Off. of Expt. Stations, 1906, p. 424.

As to the cost of thinning, it is more largely apparent than real, though some have argued against thinning because of the cost. Under reasonably favorable conditions very little of the fruit that is on the trees when the thinning is done would drop prematurely. Therefore, if it is not picked and thrown on the ground at thinning time, it will have to be picked and put in a basket at harvest time. Hence not to thin merely postpones the time when the fruit is picked. Obviously on a well-loaded tree, a bushel of peaches in which there were 140 fruits could be picked, graded, and packed much more quickly and economically than one in which there were 260 fruits.

When the thinning is properly and wisely done, results similar to these illustrations are habitually obtained.

2. While the effect of thinning on color is not capable of so tangible illustration as the effect on size, the influence has been habitually noted, the fruit on trees that are not overloaded being markedly better colored than on overloaded trees.

3. Generally speaking, almost any plump, fully developed, good-sized fruit is of better flavor than one that is small because of the unfavorable competition under which it is developed. This factor, however, has less commercial importance than items 1 and 2, since the market price is fixed largely by size and color.

4. The influence on uniformity of ripening is doubtless somewhat variable, but in some cases it is possible to gather all the fruit from a properly thinned tree at one picking, whereas two and three pickings, at least, are usual. To affect appreciably the uniformity of ripening, considerable care is presupposed in selecting the fruits that are to remain on the tree when thinning is done.

5. The decrease in the labor of picking and packing has already been touched on, so far as it has to do with reducing the number of fruits that must be handled. While thinning may reduce somewhat the total bulk of the fruit produced, it habitually gives more fruit of a good marketable grade.

Thinning also very much reduces the labor in grading, which is virtually a part of the packing. In thinning care should be exercised to remove the imperfect fruits, all of which would probably be seconds or culls when graded. Thus, the bulk of low-grade fruit is much reduced by careful thinning.

6. The effect on the tree of wise thinning extends far beyond the current crop, for it is a mortgage on future crops if the tree is seriously depleted by overbearing. Definite mention is made in the quotation from Starcher under item 1 of the comparative condition of the fruit-buds on well-thinned and unthinned trees. The inherent condition of individual trees, their strength and vitality, and the way in which they have been maintained are all factors in the depletion resulting from overbearing, but the tendency is well defined and unmistakable. Moreover, it has been observed frequently that trees which are depleted from any cause are much more likely to suffer winter-injury than are trees in good condition. The injury, when it occurs, may be to the fruit-buds or to the woody parts.

7. Since this item is a corollary of item 6, no further discussion is here necessary.

8. Thinning may reduce materially the bulk of the fruit, therefore the weight of the crop that a tree develops to maturity, even though the general result is an increase in the quantity of the paying grades. Further, thinning in many cases equalizes the distribution of the weight. The

relation between the weight of the crop, when excessive, and the breaking of the limbs from overbearing is evident.

METHOD OF THINNING

There is but one satisfactory means of removing the fruits in thinning, and that is by hand. To thin by beating off the surplus, as is sometimes done, has nothing to commend it, and there is no substitute for the hand that serves the purpose. Further, the grade of the fruit at harvest time is determined in a large measure by the care and intelligence exercised in thinning. By permitting only fruits that are entirely free from all blemish, uniform in size and form and in degree of development, to remain on a tree when the thinning is done, grading at the packing table will become a simple matter and there will be a minimum of fruit not of high grade.

WHEN TO THIN

The common practice of thinning as quickly as possible after the "June drop" fixes the time when the operation should be begun as definitely as it is possible to state it. The "June drop," however, may not occur in June as the term might imply, and it may, therefore, be misleading without further explanation. This term, however, has considerable significance. As a rule, many peaches start to develop and grow for a time, and when they reach a certain size drop off. This dropping occurs within a few weeks after the blossoming period and in many peach-growing regions it takes place, as a matter of fact, during June. It is a period recognized by all experienced peach-growers.

The drop may be light, quickly passed, and almost unnoticed; or it may be very heavy and occur during a rather

PLATE XXIV. — *Top*, a spray-house equipped for extensive operations; *center*, heaters distributed in an orchard ready for use; *bottom*, a young apple orchard furrowed for irrigation. Water is distributed in peach orchards in the same way.

long period. Not infrequently peach-growers may think they have a remarkably heavy set of fruit which will call for extensive thinning, but by the time the "June drop" is over, it may appear that the crop is very light. An excessively heavy drop is commonly associated with some adverse weather condition during the blossoming period. In any event, when thinning is to be done it should be accomplished before the pits begin to harden if the depleting effect on the tree of an excessive crop is to be avoided.

Though the proportionate weight of the pit to the entire fruit is small, its composition is an important factor. The relation of the size of the pit to the whole fruit varies widely in different varieties, ranging from about 3 per cent in weight in some sorts to as high as 7 and 8 per cent in Mountain Rose, Early Crawford, and Elberta. However, the size of the pit in a given variety is not greatly influenced by the size of individual fruits. The small fruits borne on an overloaded tree develop pits nearly as large in size as the much larger fruits on a well-thinned tree.

The composition of the flesh, stones, and kernels of peaches at different times in the season as given by Bigelow and Gore[1] is of interest in the present connection, since the figures offer a clear explanation for the advantages of early thinning. In the work reported, the composition of each of six different varieties of peaches at three different periods in the development of the fruit is given. The varieties used were Triumph, Rivers, Early Crawford, Elberta, Heath, and Smock. The different periods in the seasonal development of the fruit for which the composition was determined represented the time immediately following the "June drop"; when the stone had hardened, that is, when it offered appreciable resistance

[1] Bur. of Chem. Bull. 97.

to a knife in cutting through it; and the market-ripe stage. The average composition of all the varieties is shown in the following table:

TABLE VIII. — AVERAGE COMPOSITION OF SIX VARIETIES OF PEACHES AT DIFFERENT STAGES OF GROWTH

STAGE OF GROWTH	WEIGHT OF				TOTAL SOLIDS IN		
	Peach	Flesh	Stone	Kernel	Flesh	Stone	Kernel
	Grams	(%)	(%)	(%)	(%)	(%)	(%)
June drop . .	9.51	64.55	32.50	2.94	14.77	9.37	6.89
Stone hardened.	16.75	71.54	25.82	2.89	16.97	27.35	7.54
Market-ripe . .	73.59	92.49	6.86	0.65	14.04	66.94	44.78

In the next table the results shown in Table VIII are expressed in terms of grams to a peach.

TABLE IX. — AVERAGE COMPOSITION, IN TERMS OF GRAMS TO A PEACH, OF SIX VARIETIES OF PEACHES AT DIFFERENT STAGES OF GROWTH.

STAGE OF GROWTH	WEIGHT OF				TOTAL SOLIDS IN			
	Whole Peach	Flesh	Stone	Kernel	Flesh	Stone	Kernel	Whole Fruit
	Grams	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*	*Grams*
June drop . .	9.51	6.116	3.116	0.278	0.903	0.293	0.019	1.216
Stone hardened	16.75	11.890	4.370	0.484	2.007	1.171	0.0362	3.510
Market-ripe . .	73.59	68.110	5.009	0.471	9.719	3.179	0.2061	13.104

The most important feature of these tables from the standpoint of thinning is in showing the rapid rate of increase of the solids in the stones while passing from the "June

drop" stage to the hardening stage. The first analyses of the "stone-hardened" stage were made June 23 and 28, depending on the variety. During this period of fifteen to twenty days, the percentage of solids in the stones nearly trebled. The fact is also brought out that though the average weight of the pit (stone and kernel combined) is only about 7 per cent of the weight of the whole fruit, the total solids in the pits comprise more than 25 per cent of the total solids in the whole fruit.

It is well to observe also that the solids in the flesh remained fairly constant throughout the development of the fruit, the variation ranging from a total of 14 to about 17 per cent, a difference of only 3 per cent, while the solids in the stones constantly increase from about 9.3 per cent at the June drop period to nearly 67 per cent at the market ripe period.

These figures, therefore, furnish a scientific basis for early thinning, also for the frequent observation that the development of a large number of pits makes a heavy demand for plant-food.

DISTANCE BETWEEN FRUITS

The grower must have some ideal in mind when he begins to thin, otherwise the result will be exceedingly variable. The usual guide is to thin the fruit as far as practicable so that those left on the tree shall be evenly distributed at some predetermined distance apart. The prescribed distance varies with different growers, from 4 to 6 or 8 inches. Results in experimental thinning also vary more or less, probably because of differences in the vitality of the trees. In some cases a distance of 10 inches has given optimum results, while in others a considerably shorter space seems preferable.

There is evidence, however, both experimental and practical that a space of 6 inches between individual fruits on trees in good vigor is a safe standard. In actual thinning operations this distance, serving as a guide, may be varied as individual tree conditions require. The space of 6 inches between fruits, it may be explained in order to prevent any ambiguity, refers to the distance between fruits on the straight terminal twigs which grew the previous season and on which most of the fruit is grown. In case of varieties that develop many short spur-like twigs, any rule as to distance between fruits necessarily must be adapted to meet conditions. And again, when a single branch or one side of a tree has a very light crop, or none at all, and the other side has an overburden of fruit, as frequently happens, it is reasonable to assume that the fruit on the heavily loaded side need not be thinned quite as much as it would if the opposite side also had a good crop. The compensation between different parts of the top of a tree is partial but not complete. The competition for plant-food is universal in the top of a tree. The tree takes up fairly definite amounts of water and plant-food. All leaf-buds and fruit-buds in the normal course of development throughout their life-course are competing with each other for plant-food. In thinning, the competition is reduced, though the supply of food material and moisture remains the same and goes into the development to a higher degree of perfection of the smaller number of fruits when thinning is done in comparison with the larger number when it is not done.

CHAPTER XIII

IRRIGATING PEACHES

MOST peach orchards in the intermountain and Pacific Coast states are maintained under irrigation. In the intermountain states the orchards are practically all located in valleys, and in the Pacific Coast regions they occupy both valley and foothill locations. These are all semi-arid regions where there is little rainfall. There is practically no orchard irrigation in the humid parts of the country.

Irrigation is largely an engineering feature. This is true at least to the point of getting the water to the orchard, including also putting the orchard site into the proper condition for the distribution of the water.

As a rule, a site suitable for irrigation presupposes an area that is uniformly and regularly though but slightly sloping. If the surface is not naturally regular and uniform, a practically perfect plane, it is made so by grading and leveling. However, this is not necessarily the case, since the orchards in the foothill location shown in Plate II are irrigated through furrows which are accurately placed according to the contours.

The discussion in the present connection does not concern any of the engineering features of the operation, nor in any large measure the details of practice, since they are fundamentally the same wherever irrigation is carried on and whatever the crop. There are, however, very naturally

certain features of the art of irrigating that apply somewhat specifically to orchard practice, though few that concern peach orchards as distinct from other deciduous tree-fruits. The more important problems that need to be touched on here center about the questions of the systems of distribution, times for applying water, and the amount of water to apply.

SYSTEMS OF DISTRIBUTING WATER

The furrow system is used very largely in distributing water in orchards. The check or basin system and flooding are used in some sections to a limited extent, but probably less now than formerly, except where the land is very level, the soil porous, and water abundant.

In using the furrow system for the first season or two after the orchard is planted, one furrow on either side of the row and run about 18 inches from the trees is sufficient, unless there is an inter-planted crop, when of course the entire area should be watered. After the first year or so, the roots of the trees will occupy so much of the space between the rows that the entire area will require watering without regard to any secondary crop. The furrows should then be spaced about 2½ feet apart if made shallow; or if made 7 or 8 inches deep they may be 3 to 4 feet apart. Shallow furrows rather near together are usually preferable. Since the feeding roots soon reach considerable distance from the tree, it is unnecessary after the first year to run the furrows nearer the trees than 3 to 4 feet; but cross furrows extending between the trees in the rows should be made as well as in the spaces between the rows. Plate XXIV shows irrigating furrows in a young apple orchard. They are commonly made in the same manner in peach orchards.

According to Fortier,[1] it is doubtful whether the furrows between head ditches should be over 600 feet long because of the length of time it requires the water to reach the farther end. In sandy or gravelly soils, where the water sinks in rapidly, the furrows should not exceed 200 feet in length.

A slope of 3 to 4 inches to 100 feet of furrow is desirable. If too little slope, the water runs very slowly; if too much, the rate of flow is too fast. If the slope is more than 8 to 10 inches to 100 feet, the trees should be planted on the contour, or the furrows made on the contours without regard to the tree rows, or some other means adopted, if possible, to reduce the slope of the furrows. Where too steep, it becomes impossible to distribute the water evenly.

In operating, considerable care must be exercised that the openings in the head ditch be made of such size that the rate of delivery will insure an even distribution of water throughout the length of the row. Where the soil is loose and easily eroded, the water should run slowly.

The basin or check method consists of making cross ridges of soil between the trees in both directions so that each tree is thus made to occupy the center of a basin. This method is applicable where the land is flat and the soil is of such a nature that water percolates very rapidly. The water is run from one basin to another by making breaks in the ridges, or by movable spouts or pipes. The ridges used in this method of irrigation may be seen in Plate XX. The method is objectionable in that the attendants have to stand in mud and water while operating.

Flooding is not much used. It is applicable under conditions similar to those for which the check system is used,

[1] Farmers' Bull. 882.

but water must be abundant to permit of the successful operation of this system.

WHEN TO IRRIGATE

The only true guide as to when water should be applied is the moisture condition of the soil. In actual practice, where an orchard is located on a party ditch, as is commonly the case, a grower must use the water when his turn comes, or at more or less regular intervals depending on the rules under which the party ditch is operated or on the abundance of water.

While the soil-moisture conditions determine the proper time for applying water, the grower learns in a measure to correlate those conditions with the appearance of his trees. There are certain conditions which should be avoided, the most important of which are extremes of moisture. The trees should never be allowed to become the least wilted from lack of moisture and they should not be overirrigated. The latter is a common tendency where water is abundant.

Moisture exists in the soil in three forms or conditions, hydroscopic, free, and capillary. Hydroscopic moisture is that form in which it is so closely identified with the soil particles as to be driven off only by a high degree of heat. Dry road dust that is blown about in the wind contains moisture in this form. It is of but little if any use to plants in this form.

Free moisture is the form in which water is so abundant that it can be seen as such. It is subject to gravity and passes off in drains, if the soil is provided with them. It so fills the spaces between the soil particles that air cannot enter. The chemical and biological changes and other

activities necessary to maintain the fertility of the soil cannot take place if the soil is filled with free moisture for any considerable period of time. Trees growing on such soils will suffer in various ways or even die.

Capillary moisture is the form which is of benefit to the plants growing in the soil. This is the form of moisture that is in soil that looks moist, feels moist to the touch, and when pressed together firmly in the hand will adhere together, but readily crumbles when broken apart. This form of moisture exists in the soil as a thin film about the soil particles. It is this condition of soil-moisture that the grower should aim to maintain so far as possible.

In the matter of soil-moisture it will not suffice to be guided by the appearance of the surface, since that may be very deceptive so far as the condition of the subsoil is concerned. With the aid of a post-hole digger or by some other means, a grower should examine the soil frequently at a considerable number of representative places in the orchard to a depth of several feet, as far down at least as the roots penetrate or perhaps even deeper than that. The subsoil which holds the bulk of the root system may become too dry, or the surface may be dry and a short distance below the subsoil may be "water-logged," that is, filled with free water that has not drained away.

The character of the soil and its location will influence greatly the frequency of the applications. Land naturally well drained because of its location will usually require more irrigation than land that is poorly drained. Soil naturally retentive of moisture will require less than very leachy soil. Some soils, because of their texture, are almost impervious to water. These are difficult to irrigate. They should not be allowed to become very dry since in that

condition they "take" water very slowly. In such soils, however, the furrows, when that system is being used, may be farther apart than in sandy soils, since water moves laterally in them with comparative freedom. However, the furrows should be fairly deep. In light soils the freest movement of the water is downward, hence the necessity for placing the furrows relatively near together, else a section of soil between the furrows will remain dry to a considerable depth and thus seriously restrict the functioning of the roots within those sections.

The particular time or period, therefore, when the water should be applied becomes a matter of judgment on the part of the peach-grower, based on his knowledge and interpretation of soil conditions. Paddock and Whipple[1] call attention to a prevailing opinion among fruit-growers, that orchards should not be irrigated when in bloom. In discussing this and other related points these authors state that while proof is lacking that irrigating during the blossoming period actually interferes with the setting of fruit, there is little occasion to irrigate until after the fruit has formed if the trees go into the winter with a good supply of moisture in the soil.

If the soil is too moist during midsummer and later, fruit-buds may not form well, as the tendency of the trees under these conditions is to make excessive wood growth at the expense of fruit-bud formation; besides, the fruit of the current crop may not color well. Also, if the trees are kept growing rapidly late in the season by excessive moisture in the soil, the wood will not ripen well and winter injury is likely to result. On the other hand, trees that have become rather dry during the late summer and early fall should be

[1] "Fruit Growing in Arid Regions."

given a thorough irrigation after they have become dormant and before the ground freezes, otherwise winter injury due to excessive drying out of the trees is likely to occur.

The best experience in the leading irrigated fruit districts seems to indicate that from three to five irrigations give best results, the number varying according to the soil and other conditions. Frequently two to four summer applications and one late fall application prove effective and satisfactory.

As a rule, where drainage is good and the water-table is not too high, heavy applications of water at relatively long intervals are preferable to lighter applications at correspondingly shorter intervals. However, Batchelor[1] found that on a gravelly loam soil applications of water every seven or eight days produced a more continuous and greater twig growth and a larger crop of fruit than the same total amount of water applied at intervals of ten to twelve days. And further, that poor color was associated with a small amount of water. There was no marked difference in color of fruit from the trees receiving large and medium amounts of water.

AMOUNT OF WATER TO APPLY

From what has already been said, it is apparent that no specific limitations can be placed on the amount of water that a peach orchard should receive, either in a particular application, or in total for the season. The character of the soil, the size of the trees, the head of water, the rate that it flows in the furrows, and the manner in which the orchard is handled after water has been applied, are all factors that are related closely to this problem.

[1] Utah Expt. Sta. Bull. 142.

The aim should be to moisten the soil thoroughly to the desired depth. This will include the entire body of soil, and the subsoil occupied by the roots, at least to the depth of several feet. In some instances the roots may penetrate to a greater depth than is usually the case. The grower ought to trace from time to time some of the main roots of typical trees as they increase in age in order that he may gain positive knowledge as to just where they are placed.

If while irrigating, the grower examines the soil frequently in the same manner as suggested on an earlier page (page 309) in determining when an application is necessary, he will be able to determine also when the moisture conditions are such as to call for turning off the water. It is as unsafe to be guided by the appearance of the surface at this time as it is to take the surface conditions for an index as to when water should be applied.

As soon as the soil can be worked following an irrigation, if it is clean tilled, as is the case with most peach orchards, it should be given a thorough cultivation to conserve the moisture. This should be repeated as often as conditions justify. Irrigation should be considered in no sense as a substitute for tillage so far as soil-moisture conservation is concerned. The grower who attempts to make this substitution is likely to have serious soil troubles from excessive irrigation. Excessive irrigation is also doubtless largely responsible for various other troubles that are not known to the grower in humid regions. Too much water is perhaps more objectionable than not quite enough, and where irrigated land is poorly drained serious soil troubles are likely to occur.

CHAPTER XIV

A CONSIDERATION OF ADVERSE TEMPERATURES

In a previous connection attention was directed to the fact that temperature is the chief limiting factor in the geographical distribution of peach-growing. By adopting special methods, the distribution may be extended somewhat so far as the minimum temperature factor is concerned. However, it is true in general that practically no region in which peaches are grown is entirely free from sporadic occurrences of adverse temperatures during the winter and early spring. Heavy losses due, usually, to the killing of the fruit-buds have been experienced from time to time in the past, and doubtless will be in the future, in nearly all peach-growing districts. Occasionally there is also serious injury to the trees, by unseasonably low, or extremely low, temperatures. A most striking example of the former is the freeze that occurred in the Michigan peach belt the night of October 9 or morning of the 10th, 1906, while the trees were still in an active vegetative condition and in full foliage, and which resulted in the death of a considerable proportion of the trees in one of the most important peach districts of the country. An example of serious tree injury from extremely low winter temperatures is the memorable winter of 1903–04, as a result of which great numbers of trees were killed or

seriously injured throughout most of the northern peach districts. This occurrence has been referred to previously in the chapter on pruning (see page 206). Examples of injured fruit-buds occur, unfortunately, often enough to be familiar experiences to most peach-growers.

It is with a view to preventing, so far as possible and practicable, the losses that are suffered from these periods of adverse temperatures which occur from time to time, that the present discussion is directed. There are certain general features, however, that may well be given consideration in the present sequence.

Not infrequently it is noted that many fruit-buds are killed when the temperature has registered a certain low minimum. A considerably lower temperature may be recorded at a later date without any appreciable increase in the amount of injury. There may be several explanations for such results.

The duration of a critical temperature may often be the determining factor. An extremely low temperature may cause little or no damage if it continues for but a short time, as is often the case, when a temperature not so low by several degrees, if long continued, may prove ruinous to fruit-buds.

The conditions during and immediately following a frost or freeze which occurs while peaches are in blossom contribute very materially to the results. If it warms up slowly and the frozen parts thaw very gradually, and especially if shaded from the sun as when the latter is obscured by dense clouds, the injury is usually much less than when the thawing is rapid or if it takes place in the direct rays of the sun.

In addition, the results are modified by the humidity of the atmosphere. Occasionally there is a snow-storm during

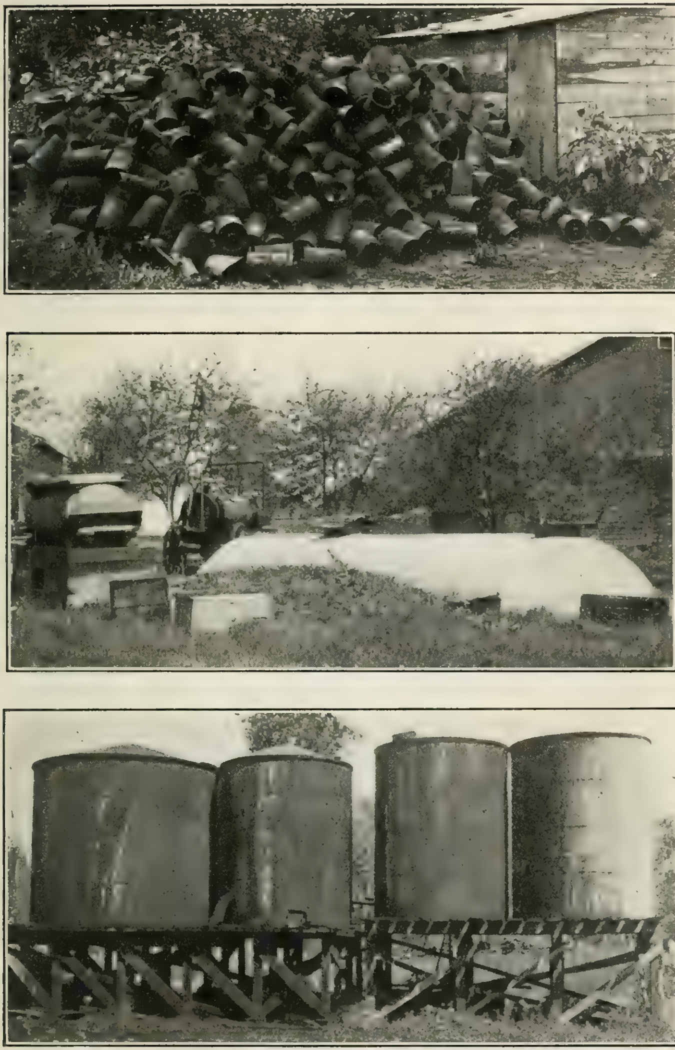

PLATE XXV. — ORCHARD-HEATING EQUIPMENT. *Top*, heaters of the "lard-pail" type awaiting storage; *center*, a cement storage reservoir for oil; *bottom*, sheet-metal storage tanks.

the blossoming period, which is followed by a dropping temperature. If the blossoms are full of snow so that as it warms up, the plant tissues which are surrounded by frozen snow or ice thaw very gradually and in the presence of much moisture, the damage is often considerably less than it would be under any other conditions attendant on the thawing. Under such conditions, even though the blossoms have been frozen, a good crop of fruit may be produced.

A very sudden drop in the temperature from a safe to a critical degree is more liable to cause damage than when the drop is very gradual. In cases of a sudden drop to a critical temperature, serious bursting of the bark of the trunks and larger limbs is likely to occur. On the other hand, reports are not infrequent of peach trees withstanding winter temperatures of 30 to 35 degrees below zero, without injury to the trees themselves, but where this occurs it usually happens that these extremes have been preceded by a long period of very cold weather. Moreover, the trees must have become thoroughly mature and well ripened before the advent of cold weather.

The fruit-buds, however, rarely survive a temperature of 15 degrees below zero, though under especially favorable conditions a peach tree will sometimes pass through a temperature of 20 degrees below zero and still produce a fairly good crop of fruit. As a rule, however, a peach-grower begins to speculate as to the chances of a crop the next season when the temperature goes much below -10 degrees. The weaker, less mature buds will be likely to be killed by that extreme even when the tree and buds generally are in a well-ripened condition. Considerable difference is noted, however, in the cold resistance of different varieties.

Adverse temperature and other climatic conditions during the blossoming period are sometimes fatal to the crop, even though no freezing occurs. The pollen will not germinate well except in bright, fairly warm weather. The insects, especially the bees which are largely instrumental in pollinating the blossoms, are not active in cold, rainy, or very windy weather. If very heavy, beating showers occur repeatedly during the blossoming period, there is danger of most of the pollen being washed away.

Thus, if any of these adverse conditions prevail in an extreme measure during the blossoming period, the setting of the fruit is likely to be very light. Sometimes when one or more of these conditions prevails, the fruits start to grow, and before they acquire much size they begin to drop, and in such instances the dropping may continue until practically no fruit is left on the trees. This doubtless may be ascribed justly to imperfect pollination on account of adverse weather conditions. The "June drop" usually consists of fruits that were not well pollinated, even when no notably adverse conditions have prevailed.

There are no means of overcoming or preventing this form of injury but precautions can be exercised and certain measures adopted that will help materially in avoiding the injury due to adverse winter temperatures and untimely spring frosts. These will now be considered.

CULTURAL METHODS IN RELATION TO WINTER INJURY

While a good location is perhaps one of the most effective ways of insuring a peach crop and of avoiding injury due to adverse climatic conditions, much can be accomplished in this direction by wise cultural methods. Some of these

cultural influences have already been discussed, but their importance may well be restated in the present connection.

In some sections of the country winter injury is quite definitely associated with insufficient soil-moisture. The trees are giving off moisture more or less continuously throughout the dormant period. If the soil is so extremely dry when winter sets in that in the slight root action which occurs, the moisture that leaves the twigs and branches cannot be replaced through the roots from the moisture in the soil, injury even to the extent of the death of the trees is likely to occur. Thus, much of the so-called "winter injury" is in reality due to a lack of soil-moisture. In regions where such soil conditions are likely to occur, every cultural precaution possible should be taken to conserve the soil-moisture. It is in this connection that the growing of cover-crops which obviously make demands on the soil-moisture late in the season may be utterly incompatible with the welfare of the trees. On the other hand, the relation of cover- and green-manure crops to the humus of the soil, and in turn the relation of the humus to the soil-moisture conditions, place much stress on the desirability of returning to the soil adequate quantities of decaying vegetable matter.

Perhaps there has been recorded no experience which more clearly shows the importance of good soil conditions in relation to winter injury than the observations of Green and Ballou[1] who made careful studies of the causes entering into the destruction of thousands of peach trees in the Lake Erie peach district in Ohio during the disastrous winter of 1903–1904 previously mentioned. Investigations were made during the following season to determine the conditions

[1] Ohio Expt. Sta. Bull. 157.

under which injury was caused and why it occurred in some orchards or in parts of orchards and not in others.

The summary of conditions incident to the freeze in question made by these authors is illuminating:

"General cause of the '*finish*' of vast areas of peach orchards in the Lake Erie fruit belt: the severe and prolonged cold of the winter of 1903–1904.

"General cause of unusual susceptibility to cold, of the orchards of said district: prevailing low vitality of the trees.

"Specific causes of low vitality of the trees: San José scale, leaf-curl, lack of nourishing plant-food, imperfect drainage.

"Exceptional causes of susceptibility to cold in rare cases of apparently healthy, vigorous trees: low, moist, rich black soil which favored an extreme growth of soft, poorly ripened or matured wood; or high culture upon soil rich in plant-food which brought about similar results.

"The unusually deep, hard freezing of the earth's crust was due, directly, to the continued, steady cold, but was intensified, in many instances, by a lack of humus or vegetable matter in the soil, which constitutes nature's insulation of the surface of the earth from cold and heat.

"Providing that the orchards had been kept free from fungous disease and the San José scale, by timely and thorough spraying, no injury of trees was found where stable or barnyard manure had been used upon the ground within the last year or two previous to the winter of 1903–1904; rarely was an injured tree found standing in sod; no injury was done where the surface of the soil, beneath the trees, had been covered with even a very light mulch; little injury was done where the trees stood in fairly well drained soil containing a moderate amount of fertility and humus; no injury was

found where the trees were under the grass mulch method of culture, . . .; no injury was observed in any case where the stems of the trees had been slightly banked or mounded with a few shovels or forkfuls of soil, peat or manure.

"Very few trees which, within the past few years, had been affected with leaf-curl or infested with San José scale or borers, remained alive or uninjured; and very few trees existing upon infertile or exhausted soil, depleted of humus, escaped uninjured."

It may be still further pointed out that any influence which weakens the trees renders them more susceptible to winter injury than trees in good vigor with strong vitality. Overbearing is perhaps one of the more common and unsuspected causes of winter injury because of its devitalizing effects. The effects of any cause or condition that weakens the tree also weakens the fruit-buds. It is a matter of frequent observation that trees which are strong and on which the fruit-buds are plump and well developed will produce a good crop of fruit when other trees similarly located but lacking in vigor will produce little or no fruit, following a hard winter or a frost, even though the weakened trees may blossom. The embryo fruits or other essential parts of the blossom of a weakened tree are themselves weak, and are killed by adverse conditions which the stronger blossoms are able to withstand. In general, trees that are strong and vigorous blossom later than do those which lack vitality. This is of importance, especially where injury from late spring frost is likely to occur.

The obvious course for the peach-grower is to maintain his trees in a high state of culture with a view to making and keeping them vigorous and possessed of a high degree of vitality.

In the present connection, the reader's attention is redirected to the influence of late tillage, nitrogenous fertilizers, and other cultural and maintenance operations as means of preventing injury from adverse temperatures in regions where the temperature is rather mild during the dormant period and is characterized by warm spells during which the fruit-buds start enough to become somewhat tender. It is unnecessary to repeat the details here since they are elsewhere discussed sufficiently to indicate their practical importance in orchard management. (See pages 168–169.)

Chandler[1] points out that there is considerable difference in the relative hardiness of varieties, but that those which will withstand low winter temperatures and are hardy in the northern peach districts where the winters are characterized by long, continuous periods of cold weather may be far from the hardiest varieties where the winters are characterized by warm spells with temperatures sufficiently high to start the buds.

Hardiness in the former case depends primarily on the wood becoming thoroughly ripened before cold weather sets in. Under the latter conditions hardiness depends on the ability of the tree to remain perfectly dormant during warm periods in winter. There is considerable difference in the color of the twigs of different varieties. Chandler finds that the varieties of the Chinese Cling and Chili (Hills Chili) type with green twigs are the hardiest under conditions such as prevail in Missouri.

Aside from these cultural features above noted, there are several recourses open to the peach-grower as means of preventing injury. Not all of these are practicable on a

[1] Mo. Expt. Sta. Circ. of Information, 31.

commercial scale, but they offer a measure of protection which may be of considerable value under some conditions.

BANKING THE TREES

Reference again may be made to the observations recorded in a previous section (page 319) on the effect of banking peach trees as a means of protecting them against winter injury. It is difficult to correlate this practice with the evident results in the Lake Erie peach district of Ohio during the winter of 1903–1904 but they appear conclusive so far as certain conditions are concerned.

It has been suggested that the section of a tree latest to mature and reach a state of dormancy is at the collar, or crown, or the portion just at the surface of the ground. The protection afforded by banking the trees in the instance referred to appears to give credence to this view, and that where the trees were not banked they suffered injury at the surface of the ground because they were not well ripened at that point.

Blake[1] has likewise called attention to the fact that young peach trees in some parts of New Jersey, especially during their second winter after planting and where they occupy exposed sites, may be injured or even killed as a result of the swaying of tops in the wind and the consequent opening of the soil about the trunks at the surface of the ground. The openings thus made about the trunks become filled with water which in turn freezes and injures the tree at this point. The exposure of the crown to low temperatures, as above suggested, may also explain the injury. By mounding the trees this trouble can be prevented in many cases.

[1] N. J. Expt. Sta. Bull. 231.

COVERING WITH SHEDS

Excepting where lumber is plentiful or a supply suitable for the purpose can be obtained cheaply, the building of sheds over peach trees to furnish winter protection is impracticable. In effectiveness under Missouri conditions, however, Whitten [1] reports that this method of giving winter protection to peach trees was the best of several tested. The sheds were constructed by placing posts just outside the spread of the limbs and of sufficient height to escape the top of the branches. Rafters extended from the posts, meeting over the center of each tree. Boards were placed on these with spaces between them of about one inch. The sides of the sheds were boarded down from the eaves for a short distance. This method gave almost perfect protection against winter injury to the fruit-buds and also against adverse climatic conditions which later in the spring caused considerable loss on unprotected trees. However, the cost of the sheds, including labor of putting up and taking down each season, is prohibitive on a commercial scale. If used in gardens or when the expense can be ignored, the shed should be allowed to stand in the spring until after the fruit has fairly begun to develop.

WRAPPING THE TREES

Considerable effort has been put forth from time to time, both experimentally and in practical usage, to protect peach trees from winter injury by wrapping them with various kinds of material. In brief, the method commonly used is about as follows: The trees are headed back rather heavily

[1] Mo. Expt. Sta. Bull. 38.

on the approach of cold weather. The limbs are then drawn together as much as possible and held in that position by passing a cord around them once or twice and tying it tightly. Then about the tree are placed small evergreen trees, corn-stalks, or some other suitable material which in turn are drawn closely to the tree and held in position by binding tightly with rope or some other stout cord. In some cases, stakes are driven into the ground in close contact with the covering for the purpose of protecting the tree against the strain from high winds.

In many cases, even in regions of rather extreme winter temperature, this method has been beneficial, saving a good proportion of the fruit-buds where on unprotected trees they have been all or nearly all killed. There is considerable evidence, however, which indicates that much of the benefit is due to the shade afforded by the covering at certain times, rather than to protection against cold.

The tendency where this method is used is to remove the covering too early in the spring. Serious injury has followed, sometimes, when it was taken off immediately on the passing of the period of extreme temperatures; but when left on, in part at least, until after the tree has blossomed and set fruit, the beneficial results are not lost.

WHITEWASHING THE TREE AS A MEANS OF PROTECTION

The fact that the buds of a tree, in starting into growth in the spring, respond to the temperature of the air rather than to the condition of the soil is not fully appreciated. If the air is warm enough for a sufficient length of time, a peach or other fruit-tree may blossom while its roots are still in ground

that is frozen solid. Moreover, the fact that different colors absorb heat in varying degrees is of importance in its relation to the swelling of peach buds in early spring. There is considerable difference in the color of the bark of peach varieties. That different colored branches have actually different temperatures during sunny weather in spring when there is no foliage to shade them is capable of easy demonstration by means of the simple experiment of cutting off some of the small limbs, boring a hole in the end of the stubs thus made, and inserting a small round thermometer in each one. During sunny days a very perceptible difference in temperature will be registered, the thermometers in the stubs having the darker colored bark registering the higher. This makes it apparent that the buds under the influence of the higher temperatures might be expected, naturally, to advance more rapidly than those on branches having the lower temperatures.

In line with this general result Whitten[1] has shown that when peach trees are kept thoroughly coated with whitewash during the winter, the swelling of the buds in warm spells may be prevented in a very large measure for a time and the blossoming delayed from two to six days. Under some conditions, as has been pointed out previously, the holding of the trees perfectly dormant throughout the winter and the retarding of the blossoming several days in the spring may be the means of preventing disastrous injury to the prospective crop.

However, in order to be effective, the fruit-buds as well as the twigs and branches must be kept thoroughly coated with the whitewash. The first application, under Missouri conditions, should be made the last of December and fol-

[1] Mo. Expt. Sta. Bull. 38.

lowed shortly by a second coating to insure a complete covering of every bud and twig. Usually two more applications made at intervals later in the winter and spring will be adequate, though if there is an unusual amount of rain, other applications may be advisable. The whitewash should be as thick as will pass readily through one of the standard spray nozzles. It was found in the work at the Missouri station that if the liquid with which the slaked lime is thinned in making the whitewash is about one-fifth skim milk and salt is added at the rate of a pound to every $2\frac{1}{2}$ or 3 gallons of the wash, it will adhere to the trees much better than if a plain lime whitewash made with water alone is used.

Trees treated in the manner described came through the winter with 80 per cent of the buds in good condition, as against about 80 per cent killed where the trees were untreated.

LAYING DOWN PEACH TREES

The possibility as well as the practicability of laying down peach trees and covering them with soil to give winter protection in climates that are especially severe has received some attention. The method perhaps which has been the most exploited and perhaps also the most satisfactory is one developed in Colorado by W. B. Felton and C. C. Rickard. As described by Paddock from data furnished him by Rickard,[1] the principal features of this method are as follows:

"Yearling trees are set in the spring and they should be laid down the first winter, repeating the process each season during the life of the tree. In this instance no attention is given to training or placing the roots. As soon as the trees

[1] Col. Expt. Sta. Bull. 80.

have shed their leaves and the wood is well ripened, they are ready for winter quarters. This is usually in the fore part of November, in the vicinity of Canon City. The first step in the operation consists in removing the earth from a circle about four feet in diameter around the tree. When sufficient trees have been treated in this manner to make the work progress advantageously, water is turned into the hollows. After the ground has become saturated the trees are worked back and forth and the water follows the roots, loosening the soil around them so that they are pushed over in the direction that offers the least resistance. When treated in this manner the trees go over easily and with comparatively little injury to the root system. That is, providing the trees have been laid down each year. It is difficult to handle old trees in this manner that have never been laid down, and usually it will not pay to try.

"After the trees are on the ground, further work should be delayed until the ground has dried sufficiently to admit of ease in walking, and in the handling of the dirt. The limbs may now be brought together with a cord, and so lessen the work of covering.

"After experimenting with many kinds of coverings, burlap held in place with earth has proved the most satisfactory. The burlap is spread out over the prostrate tree top, as shown in the photographs [Fig. 18], taking special pains to protect the blossom buds from coming in direct contact with the earth covering. A light layer of earth is now thrown over the tree and the protection is complete.

"The critical time in growing peaches by this method is in the spring when growing weather begins. Close watch must be kept to see that the blossoms do not open prematurely, or that the branch buds are not forced into tender, white

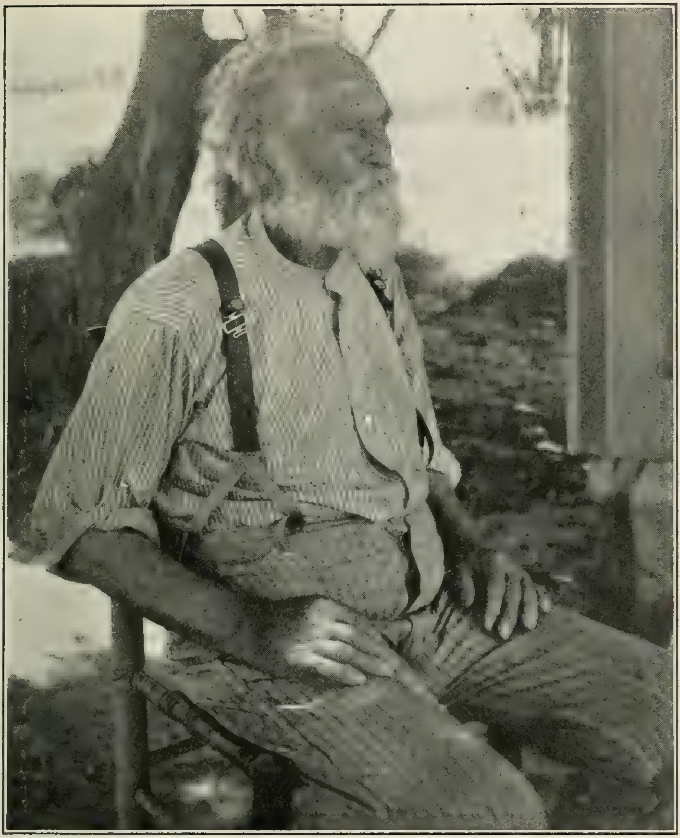

Plate XXVI. — Gilbert Onderdonk.

growth. When the blossom buds begin to open, the covering should be loosened so as to admit light and air, but it should not all be removed [Plate XXIII]. More of the covering should be removed as the weather gets warmer, but the blossoms must be exposed to the sun gradually.

"Air and light are, of course, necessary for proper fertilization of the flowers, but after this process is complete and the fruit is set, all danger from the weather is considered as being over. The trees are usually raised about the middle of May at Canon City.

"Raising the trees is, of course, a simple task. The ground is again watered and when wet enough the trees are raised. To be sure, trees that have been treated in this manner will not usually stand upright unsupported. Consequently they are propped up at an angle, usually two props being required to keep the wind from swaying them.

* * * * * * *

"This process seems to be in no way detrimental to the health of the trees, since they live as long and bear as much fruit according to the size of the top as those grown in peach sections. It is, of course, necessary to cut out the wide-spreading branches and thus reduce the size of the top in order to lessen the work of covering."

Peach trees are shown in Fig. 18 that were laid down in the fall and covered with burlap and soil. Growth is just beginning in the spring and the covering is being gradually removed. A tree is shown in Plate XXIII that is beginning to blossom in the spring and has been partially uncovered in order that the tender leaves and other parts may become gradually inured again to the full intensity of the sunlight and air.

Details of this operation are varied more or less as followed by different growers in eastern Colorado, where in past years this method apparently has been used more than in any other section, but the main features are much the same. Some growers in planting trees that are to be laid down either trim off the roots on the sides towards which and from which the tree is to be bent over, or else place all the roots in such positions when planting that they extend only at

Fig. 18. — Peach trees laid down and covered with burlap and soil for protection during winter.

right angles to the direction in which the tree is to be bent over. This plan is intended to make it easier to tip the tree over. Rickard, however, pays no attention to this detail, claiming that within a few years there is no appreciable effect on the root system of this early training.

Sometimes a "block and tackle" is convenient in raising the trees to an upright position in the spring, a horse being used on the tackle to supply motive power if necessary.

While this method of providing winter protection is hardly practicable in large scale operations, it has its usefulness and its possibilities in growing peaches for home use and for local

market in sections where it would be impossible to succeed without some means of protection.

Under the conditions in Colorado where the above method was developed, it was found that two men could lay down in the fall about twenty-five trees in a day. In sections where irrigation is not practiced, more attention to loosening the roots before the trees are tipped down would doubtless be necessary.

While certain other methods of laying down trees for winter protection, such as planting with the trunk in a horizontal position along the ground, with a view to turning or twisting the top sidewise when it is put down to be covered, have been tried, and apparently with some measure of success, the cost is prohibitive except as a small, home orchard proposition, or where the grower has little or no competition in marketing the fruit and is able to secure prices that are commensurate with the cost of production.

ORCHARD HEATING

In some fruit-growing sections of the United States, particularly in the irrigated valleys of the intermountain and Pacific coast states and to a less extent in other regions, the heating of orchards during the spring to protect the buds, blossoms, or recently formed fruits against injury from untimely frosts or freezes has been developed to a rather high degree of efficiency. The idea of giving artificial protection against low temperatures during this critical period is not new, but some of the methods are developments of the past few years.

The several methods of frost protection used from time to time are summarized by Wilson [1] as follows:

[1] Cornell Univ. Expt. Sta. Bull. 316.

"The object sought in all methods of frost protection is to hold the temperature of the air in contact with the plant above the point of danger. In the attempt to accomplish this certain principles are involved:

"1. Prevention or retardation of the escape of heat from the earth by the use of an artificial covering. The use of smudges as a means of protection against frost is based on this principle.

"2. Addition to the air of moisture in the form of vapor, with the view of obtaining the effect of liberation of latent heat as the moisture condenses. The use of damp fuel for smudges and the spraying of fires with water have this purpose in view.

"3. Heating the air by numerous small fires."

Artificial covering.

"It is a very old practice to protect plants from frost by covering them with newspapers, carpets, straw, and the like. This is a most cleanly and efficient method, but unfortunately, because of the labor and expense involved, it is applicable in practice only in small areas, such as flower beds and gardens. . . ."

Smudging.

"Smudging, particularly when damp fuel is used, combines the first and second principles mentioned above — the prevention of the escape of heat from the ground and the addition of moisture to the air. In practice smudging has not proved a very efficient method of protection. It is used chiefly at present to shield the blossoms from the sun during the morning hours following a frost, thus preventing too rapid thawing. Spraying the frozen fruit or

blossoms with water is practiced, also, with the same purpose in view. . . ."

Heating the air.

"The most practical, efficient, and economical method yet devised for protection of large areas is the direct addition of heat by means of numerous small fires properly distributed over the area to be protected."

The last method, "heating the air," is the only one that calls for further amplification in this connection, since it is the one used in recent years, largely, to the exclusion of the others. The details of practice are essentially the same for all orchards, whether peach, apple, citrus, or some other kind, though the critical temperatures for the various fruits in different stages of development obviously vary somewhat.

Three kinds of fuel have been used in orchard heating, wood, coal, and oil. Many different grades of oil have been utilized, but usually a rather heavy petroleum product of which several different brands are available have given the best results. An oil having a paraffin base is preferable to one with an asphaltum base, as the residue which remains from burning the latter is objectionable. While various grades of oil, varying in density from about 20° to 30° or even 32° Baumé, have been used successfully, the lighter oils that have a density of about 29° or 30° are perhaps preferable, though some of the "smudge oils" or "orchard heating oils," as they are variously termed, as heavy as 19° Baumé, have given good results. If too heavy, however, they do not burn well; and if too light, they burn too fast for the best results.

A half-dozen or more different types of "smudge pots" or heaters are on the market. The maker of each type naturally claims for his own points of superiority not possessed by

any of the others. None of them represents perfection. Doubtless any one of them can be used with some measure of success. The points of a good heater, or oil-pot, without regard to relative importance, are: Convenience in handling (so made that they can be stacked or "nested" when stored); construction such that a proper draft is secured when in operation; good construction so as to prevent loss of oil from leakage; adequate provision by means of a suitable cover for keeping out water when the heaters are placed in the orchard in preparation for anticipated needs; capacity for holding oil in quantity sufficient to burn for at least four to six hours. The latter is obtained in different types of heaters both by the direct capacity of the heater and in various types of reservoirs.

It is difficult to determine what type of heater is the most satisfactory, since each may possess certain advantages over the others. The lard-pail type (so called because in shape it is not unlike that of the common lard-pail) with a center draft arrangement, holding 5 to 8 quarts, usually has given good satisfaction. This type is shown in Plate XXIV where the pots are distributed in an orchard for use, also in Plate XXV where they have been assembled and are awaiting storage. An oblong, rectangular reservoir type holding about 3 gallons and provided with a sliding cover to which is attached a partition that divides the reservoir into two parts and which is regulated by opening or closing the cover, has also been considerably used.

The number of heaters or fire-pots required for a given area depends obviously on the temperature that must be counteracted and the type and capacity of the heater used. However, rarely less than 50 heaters and seldom more than 100 to the acre are used.

It has been determined by O'Gara[1] that a lard-pail type of heater having a working capacity of about 5 quarts of oil (full capacity 1½ gallons) and a surface area of about 45 square inches at the top, will consume oil at the rate of about 12½ gallons to the acre an hour when used at the rate of 50 heaters to the acre, and that where it is practically still with the wind moving not more than one or two miles an hour and where the trees are of sufficient size to cover much of the ground in the spread of the branches, the quantity of oil stated (12½ gallons to the acre) will raise the temperature 4 to 5 degrees. Where the trees are smaller and the heat escapes between them more freely or where the wind is moving more rapidly, a correspondingly larger number of heaters must be used and more oil must be consumed in a given period of time in order to maintain a given temperature. A rise of 3 to 5 degrees of temperature in an orchard using 50 to 100 heaters is generally about the limit, except under very favorable conditions, though instances have been reported in which the temperature inside an orchard was maintained at a point 10 degrees higher than on the outside.

For effective heating, it is necessary to provide some surplus in oil-pots as a margin of safety. This is the case especially since by the time about one-half the contents of the pots have been burned the oil is being consumed only about half as fast as in the beginning. Hence the pots are then giving off only half the heat that was being generated at first. The residue that accumulates in an oil-pot from the burning oil also reduces its efficiency.

In equipping an orchard for heating with oil, in addition to at least 100 heaters to the acre, or their equivalent in case

[1] Bull. 6, Of. of the Pathologist and Local U. S. Weather Bur. Sta. for Rogue River Valley, Ore.

some of the larger types of reservoir heaters are used, it is necessary to provide a storage tank or reservoir for the supply of oil, a tank wagon for distributing the oil to the heaters, besides thermometers, torches for use in lighting the pots, and other minor supplies.

The storage tank is usually made of cement or of sheet metal and with a capacity sufficient to store a supply of oil equivalent to 300 to 500 gallons for each acre that is to be heated, depending on the probable amount of heating that will need to be done. A smaller reserve would be unsafe, since if several nights occurred in succession when it was necessary to heat, as is sometimes the case, the only safety lies in having an adequate supply on hand to meet the needs. A cement storage tank is shown in Plate XXV (center), also in the background a wagon-tank for use in distributing the oil to the heaters. Some sheet metal tanks are also seen in Plate XXV.

With every heating it becomes increasingly necessary to heat effectively when a critical temperature is reached, in order to save not only the crop but what has been invested in the previous heatings.

In actual practice the pots are distributed in the orchard as the blossoming period approaches and are filled with oil ready to "fire." Their principal use is during the blossoming period and they are lighted during that period if the temperature in the orchard reaches 29° at the height of the tree tops or by the time 30° is reached if the temperature is dropping rapidly.

There are a number of different kinds of torches and lighters used in firing the oil in the pots. With one of the more effective kinds and everything working well, a man will light 250 to 300 pots in an hour.

Coal is used to some extent in heating orchards, as previously noted. It is distributed in wire baskets or sheet metal containers which are placed at intervals throughout the orchard as are the oil-pots. They are less satisfactory on the whole than oil, when the latter is obtainable at a reasonable price, since it is much more difficult to get the coal to burning than it is the oil; it requires a long time for the fires to give off much heat even after they are started, and in other ways coal is less effective than oil for orchard heating. On the other hand, it has certain advantages so that perhaps the ideal provision for orchard heating combines both the coal and oil equipment.

In some places, where wood is plentiful and cheap, small wood fires at frequent intervals throughout the orchard have proved as effective as any means available in warding off frosts.

DOES ORCHARD HEATING PAY?

The inevitable question which arises is whether orchard heating pays. Prices for heaters, fuel, and the other necessary equipment vary widely. It is not of importance in this connection to estimate specifically cost of equipment. It is obvious, however, that it is considerable, especially when the reserve supply of oil is considered. Probably from $40 to $70 an acre represent conservative limits, though the cost of materials tends to increase rather rapidly. The labor is considerable and much of it is wearing on the individual. Not infrequently a grower has been to the expense of heating several times in a season only to find that a neighbor who did not heat had a full crop of fruit. Or, after heating successfully for several nights, there comes a temperature so low that it cannot be counteracted, or it may be the reserve supply of

oil is exhausted, and as a result the grower loses not only his fruit crop, but all the cost of the fuel, labor, and energy previously expended in trying to save it.

While some years ago orchard heating was much exploited and widely practiced, its limitations are more narrow than was at one time believed to be the case. The limitations are economic rather than physical. Given an adequate number of heaters and a sufficient supply of oil, the grower can hold a temperature in an orchard above the danger point, under all ordinary conditions in any of the well-defined peach-growing regions. But there has come to be a strong conviction among peach-growers that where it is necessary to heat an orchard often enough to warrant the expense of equipping it for heating, the region or locality is such that some crop other than peaches had better be grown. As a result of this growing conviction, heaters are now rarely used in some regions where a few years ago the practice was very general.

Another factor in this consideration, or rather the same factor from another standpoint, is the margin of profit in growing and marketing the crop. The peach-grower has not been able in recent years to operate on any assurance of large profits. Hence the added expense of heating, or even of maintaining the investment represented in the equipment, including a reserve supply of oil, has become the economic factor above indicated.

On the other hand, where a fruit crop is habitually grown and handled on a sufficiently large margin of profit to stand the expense, the equipping of an orchard for heating is practicable. For instance, in one of the lemon-growing districts of California, the management of one of the large companies discarded a supply of ordinary type heaters as

inefficient and equipped their grove with a large reservoir type each holding seven gallons of oil, representing an investment in equipment and supplies of $180 an acre and an estimated annual acre charge for interest, upkeep, deterioration, and the like of $33 an acre. However, the margin of profit in this case was believed to justify the cost of this form of crop insurance.

CHAPTER XV

ANNUAL COST FACTORS IN GROWING PEACHES

From a business standpoint it is important that a peach-grower should know what it costs him to produce a crop of fruit. From the orchard management standpoint, it is an exceedingly difficult matter to determine accurately. The price and efficiency of labor, seasonal conditions, and cost of supplies and equipment vary from year to year. The size of the crop also varies. The variation in the crop from year to year is perhaps the most uncertain factor of all in determining costs. The orchard must be maintained whether the crop is light or heavy, or even if there be none. Most of the overhead charges, including management, interest on the investment, taxes, and the like, are constant factors of expense. If the crop is light, some of the labor items, thinning the fruit for example, are reduced in proportion to the size of the crop, but for the major operations the cost is not greatly affected by the size of the crop. The profits, therefore, come largely from the regular production of good crops.

While it may be both desirable and practicable for the grower to keep a very accurate cost-account with his orchard, his figures would be little more than suggestive so far as other orchards are concerned, but of value in that respect. A careful consideration of the annual cost factors, however, is of definite concern to every grower, at least so far as they have to do with orchard maintenance.

For the purpose of calling to the attention of the reader the more important annual cost factors in the growing of peaches, the following citations are made:

The cost of growing peaches in the Potomac Valley in West Virginia has been investigated by Arnold.[1] The cost factors which he discusses are of definite interest in the present connection. Because of their relation to some of the maintenance operations, the soils used for peaches in the region in question are important to note:

"The two types of soil considered most favorable for peach orcharding in the mountainous section of the basin of the Potomac are the 'chert' soils, derived from a limestone which in the process of disintegration has left hard, flinty, loose rocks lying on top of a rich, dark loamy, sometimes sandy soil, and the red soils derived from a red and pink shale and sandstone.

"The chert land usually drains well and does not wash, except in particular cases where the land is very steep and is underlain by a hard, impervious clay. It is usually found on the sides and tops of long steep ranges, such as Romney Mountain, just west of Romney, or on the tops and sides of the knoblike mountains near Keyser, W. Va. Besides being very fertile, the loose rock lying on the surface holds the moisture, a condition found to be very important in peach-growing.

"The red soils are found principally on the east slopes of mountain ranges and high valleylike areas between the hills, known locally as 'levels.' These lands as a rule have a more level topography and are usually free from large, loose stones. On the hillsides, however, these soils are shallow, sometimes being only a few inches deep over the sandrock or

[1] U. S. Dept. of Agr. Bull. 29 (1913).

shale lying beneath. Two and four horse implements are worked to advantage on such soils, thus lessening the cost of cultivation, while on the chert lands one and two horse implements must be used."

As a rule the trees do not grow as large on these soils as they do on the fertile loams that occur in some of the other peach districts, hence they are more easily handled in certain respects.

Of the seasonal activities in the region in question, Arnold gives a basis of cost-accounting as follows:

Tillage. — The orchards are cultivated three to six times each season. Where perfectly clean tillage is given on some of the more level, smooth lands, six to eight cultivations with horse implements are necessary. Depending on the number of cultivations, soil, and topography, the cost an acre a year varies from \$5 to \$15 with \$2 additional where a cover-crop is used. The usual cost for tillage, however, on the red soils is about \$10 an acre a year; on the chert lands, about \$15.

Fertilizers.— Most of the growers in this region find it pays to use fertilizers with considerable regularity. The custom is to apply 250 to 500 pounds to the acre of a high-grade complete fertilizer. (From what is stated in the chapter on fertilizers, it may be questioned whether in this district a complete fertilizer can be used economically in the average orchard.) With prices that have prevailed in the past the fertilizer cost has averaged about \$6.25 an acre each year.

Pruning. — The number of trees that a man may be expected to prune in a day varies, of course, with the size and character of the tree as well as the expertness of the man. Under average conditions, however, 1000 one-year-old trees a day should be pruned by one man, 500 two years old, 200 three years old, and 125 four years old. Peach trees are

PLATE XXVII. — FRUITS OF DIFFERENT PEACH RACES. *UPPER left*, the Elberta, North China race; *center*, small type of peach blossoms; *right*, Peen-to variety, Peen-to race. *LOWER*, *left*, the Jewel, seedling of Waldo; *center*, Waldo, seedling of Peen-to; *right*, two fruits Honey variety, South China or Honey race.

not allowed to develop large heads, so that after the trees are four years old one man may be expected to prune about 100 trees a day.

Spraying. — The spraying outfit on the more level, smooth lands consists of a tank, a 3 or 3½ horsepower gasoline engine, and other fixtures mounted on a truck and hauled by a two-horse team. The number of trees an outfit and crew may be expected to spray in a day will vary, of course, with the size of the trees, the character of the land on which the spraying is done, the convenience of facilities, as well as the purpose for which the spraying is done. Three men operate each outfit and in orchards six to twelve years old on smooth land will spray 500 to 600 trees a day when in the dormant state and 800 to 1000 trees a day when in leaf. These same units would apply to apple trees at about the same age. As a rule, peach trees are sprayed three times a year — once in March for San José scale with the concentrated lime-sulfur solution and twice for brown-rot and scab with the self-boiled lime-sulfur mixture, once soon after the petals fall, and again about three or four weeks later. In the two later sprayings arsenate of lead is added to the lime-sulfur mixture as a remedy for the curculio. A few have found it necessary to make a third application with that mixture during the summer to prevent the brown-rot, especially on the late-maturing varieties.

Digging out peach-borer. — The implements used are a trowel, knife, and sometimes a piece of wire to aid in digging out the borers. The trees should be gone over twice each season — spring and fall. Under average conditions one man will "worm" 50 full-grown trees a day.

Thinning. — After the "June drop" the fruit may need thinning. This is an operation that adds considerably to

the expense of producing the crop. In the average large orchard, for varieties which fruit heavily and require thorough thinning, one man will thin 20 to 25 trees a day.

In addition to these annual cost factors in the operation of an orchard, the permanent equipment which must be maintained is considerable. Arnold enumerates the equipment for a 260-acre orchard so located that the owner must provide living quarters for his crews as follows:

"The average cost of equipment on several large orchards was found to be, in terms of the area of the farm, about $30 per acre. Many are equipped at much less cost. A great saving may be made where companies of large capital construct very cheap cottages for summer camps only. Such companies having orchards in different localities of a section may shift their forces from one orchard to another when needed, thus enabling them to economize in labor. In such cases the total equipment need not cost over $15 to $20 per acre.

"On a 260-acre orchard the equipment of 1 boarding house, $900; 1 packing house, $900; 1 barn, $900; sleeping quarters for 40 men, $600; 3 tenant houses, $1200; 3 sprayers, $750; 12 horses, $2400; implements and tools, $500; 4 wagons, $260; total, $8410, or $32.36 per acre. On a 400-acre orchard the equipment was 5 tenant houses, $4000; 10 packing sheds, $400; camp building, $1000; barn with water equipment, $1000; 5 spraying outfits, $1250; 16 mules, $3200; 6 wagons, $390; harrows, plows, etc., $500; miscellaneous tools, $150; total, $11,890, or $29.70 per acre."

The values given in this summary are those which obtained in 1913. Some articles of equipment have advanced since these estimates were made. It will be noted that the

equipment investment apart from the land is given at $15 to $20 to approximately $30 an acre.

Barden and Eustace[1] have given a detailed financial account with a fifteen-acre peach orchard in Michigan which is instructive and of value here. The orchard contained about 1550 trees planted 20 by 20 feet and made up of the leading varieties to be found in the usual Michigan orchard. Manual labor, except pruning, was charged at 15 cents an hour; 20 cents an hour was allowed for pruning. Horse labor is rated at 15 cents an hour for a team of two horses. Hauling to market is a flat rate of $2 a trip. The figures for the sixth year of the orchard (which was for the season of 1912) are apparently typical of this orchard in full bearing. They are given in Table X.

It will be noted in the table that a flat rate charge of five dollars for the fifteen-acre orchard is made for the equipment and that interest on the land is included in the account; but obviously there are other overhead expenses, such as supervision and taxes, which if included would materially increase the cost of production, and decrease accordingly the net profit.

The increasing annual costs in the development of an orchard from its first to its eighth year is shown by McCue[2] in reporting on the Delaware station orchard. The orchard in question consists of 1033 trees, comprising 55 Champion, 320 Belle, and 658 Elberta. The trees are planted 20 by 20 feet; the orchard, therefore, contains slightly more than $9\frac{1}{2}$ acres of land. The orchard is maintained for experimental purposes and is divided into many different blocks for fertilizer and cover-crop investigations. It is, therefore,

[1] Mich. Expt. Sta. Special Bull. 63.
[2] Del. Expt. Sta. Bull. 113.

TABLE X. — LABOR COSTS OF OPERATING AND FINANCIAL STATEMENT OF A MICHIGAN PEACH ORCHARD IN ITS SIXTH SEASON

Item	Total Hours		Total Cost	Hours per Acre		Cost per Acre
	Man	Horse		Man	Horse	
Lime-sulfur, 1475 gal.			$18.44			$1.23
Applying same	40	40	9.00	2.66	2.66	.60
Trees, 16 at 10¢.			1.60			.10
Planting same	4		.60	.26		.04
Pruning	367		73.40	24.46		4.89
Raking brush	45		6.75	3.00		.45
Hauling brush	20	20	9.00	1.33	1.33	.60
Manure, 12 loads			18.00			1.20
Applying same	10	30	3.75	.66	2.00	.25
Plowing, 1 horse	33	33	7.42	2.20	2.20	.49
Plowing, 2 horses	38	76	11.40	2.53	5.06	.76
Harrowing	114	228	34.20	7.60	15.20	2.28
Hoeing	34		5.10	2.26		.34
Sowing cover-crop	10		1.50	.66		.10
Oats, 12 bushels at 40¢			4.80			.32
Clover, 1 bushel at $4.00			4.00			.26
Thinning	113		16.95	7.53		1.13
Picking	567		85.05	37.80		5.67
Trucking	164	164	36.90	10.93	10.93	2.46
Packing	397		59.55	26.46		3.97
Hauling, 33 trips			66.00			4.40
Packages			264.43			17.62
Equipment charge			5.00			.33
Interest on land			90.00			6.00
Totals	1,956	591	$832.84	130.34	39.38	$55.49

Received from 2128 bushels of peaches	$2,920.99
Total cost	832.84
Net profit	$2,088.15
Net profit per acre	139.21
Average price received per bushel	$1.38
Cost per bushel	.40
Net profit per bushel	$.98

not typical of a commercial orchard, yet the financial showing as far as yields and returns are concerned is probably above those of the average commercial plantation.

The orchard was planted in the spring of 1908. The first season corn was inter-planted. In subsequent years clean tillage has been given until about the first of August, with five to seven cultivations each season. With the exception of one season, the trees have been "wormed" for borers twice each season. Pruning and spraying have been done according to the usual program for these operations.

The labor is estimated at 15 cents an hour; the time of a man and one horse at 27½ cents an hour; a man and two horses at 40 cents an hour. For 1908 and 1909 the cost of labor and materials was estimated. In subsequent seasons daily labor records have been kept. The figures in Table XI summarize the labor and material costs for each season from 1908 to 1915 inclusive.

It will be observed that the table is not intended to show the cost of developing an orchard nor of producing peaches, since no overhead charges are included in the items specified. Such charges consist of supervision, interest on the investment, taxes, depreciation of equipment, and possibly other minor items. In some sections in which the price of land is high, the interest on the investment represents the largest single acre item of cost in the growing of fruit. The figures in the table below, however, are of value in indicating the trend of annual increase in the various cost factors aside from overhead charges from the first season of an orchard until it reaches maturity.

This orchard bore its first crop in 1912. The annual average yield a tree of the two principal varieties which included

TABLE XI. — SUMMARY OF ANNUAL COST FACTORS FOR AN ORCHARD IN DELAWARE OF 1033 TREES (ABOUT $9\frac{1}{2}$ ACRES) FROM ITS FIRST TO ITS EIGHTH SEASON, INCLUSIVE

	1908	1909	1910	1911	1912	1913	1914	1915	TOTAL
Pruning and hauling brush	$1.50	$4.50	$10.00	$38.00	$59.76	$121.90	$104.56	$133.48	$474.07
Spraying labor		3.00	10.50	28.64	85.51	75.25	169.25	137.22	509.37
Spraying materials		.80	16.45	19.80	47.40	47.84	70.33	76.72	279.34
Cultivation and sowing cover-crops	27.00	52.13	57.74	76.20	42.71	63.11	41.36	51.58	411.83
Mixing and applying fertilizers	12.00	8.00	15.80	8.00	8.00	8.00	8.00	8.00	75.80
Fertilizers	55.58	62.00	66.36	58.50	52.50	49.31	56.74	53.92	454.91
Cover-crop seed		12.00	12.00	12.35	12.00	12.50	12.50	13.75	87.10
Worming		3.00	10.00	13.99	12.60	16.98	22.65	25.46	104.68
Summer pruning				18.99	71.13[1]	25.60		8.70	124.42
Harvesting				6.82	82.35	59.39	237.04	384.76	770.36
Baskets and crates				1.00	94.20	56.00	410.70	485.00	1,046.90
Hauling			5.00		2.00	4.76	10.05	1.69	23.50
Time on repairs of tools					7.72	5.87	15.08	9.06	37.73

[1] Includes worming. Items could not be separated.

TABLE XI. — (*Continued*)

	1908	1909	1910	1911	1912	1913	1914	1915	TOTAL
Repairs to trees .								5.70	5.70
Freight bills chargeable to orchard	10.00	10.00	10.00	17.00	39.00	32.00	75.66	58.89	252.55
Cost of trees at 4 ¢ each	41.32								41.32
Thinning and propping . . .							52.68		52.68
Hoeing about trees	3.15	14.40							17.55
Preparation of land	40.00								40.00
Staking	7.85								7.85
Planting	17.50								17.50
Cost of seed and planting corn crop	6.00								6.00
Thinning and hoeing corn . . .	11.00								11.00
Harvesting corn .	30.00								30.00
Lime and application			8.75						8.75
	$262.90	$169.83	$222.60	$299.29	$616.88	$578.52	$1,286.60	$1,454.29	$4,890.91

TABLE XII.—ANNUAL YIELD TO A TREE AND ESTIMATED YIELD TO AN ACRE IN HALF-BUSHEL BASKETS AND 4-YEAR AVERAGE OF ELBERTA AND BELLE TREES FROM THEIR FIFTH TO EIGHTH SEASONS, INCLUSIVE

YEAR	ELBERTA						BELLE					
	PER TREE			ESTIMATED PER ACRE			PER TREE			ESTIMATED PER ACRE		
	Picked Fruit	Drops and Culls	Total Baskets	Picked Fruit	Drops and Culls	Total Baskets	Picked Fruit	Drops and Culls	Total Baskets	Picked Fruit	Drops and Culls	Total Baskets
1912	1.30	.08	1.38	139.86	8.64	148.50	2.19	.09	2.28	236.52	9.72	246.24
1913	1.65	.10	1.75	178.20	10.80	189.00	.01		.01	1.08		1.08
1914	5.21	.94	6.15	562.68	101.52	664.20	5.88	.75	6.63	635.40	81.00	716.04
1915	5.62	1.61	7.23	603.96	173.88	777.84	5.88	1.23	7.11	635.04	132.84	767.88
Total	13.78	2.73	16.51	1,484.70	295.04	1,779.54	13.96	2.07	16.03	1,507.68	223.56	1,731.24
4-year Average	3.45	.68	4.13	371.18	73.76	444.94	3.49	.52	4.01	376.92	55.89	432.81

658 trees of Elberta and 320 trees of Belle is given herewith in Table XII.

While the figures in Tables X, XI, and XII give the reader nothing conclusive with regard to the cost of growing peaches, they direct specific attention to the more important annual cost factors, other than those included in what are commonly termed "overhead charges."

No attempt is made in the present connection to discuss the matter of profits. Obviously they must vary widely from year to year, since they de-

pend on factors that are variable. There is close connection between the market price and the abundance of the supply of fruit on the market at any time. In seasons of large production, the average returns to the grower are commonly small. Not infrequently a comparatively small crop throughout the country, or in a region which ordinarily supplies the markets during a rather definite period, may bring the growers actually more money because of the high prices received, than does a much larger crop which because of its abundance makes prices low.

So far as individual orchards are concerned, aside from the matter of prevailing market prices for the fruit, the yield is perhaps the most important single factor in determining net proceeds. It costs nearly as much to produce a small crop as it does a large one. The overhead charges and the expense of tillage, pruning, and insect and disease control and other items of orchard maintenance are substantially the same regardless of the size of the crop. The principal difference is in thinning and perhaps in fertilizing in some instances, and of course there are differences in harvesting and handling the crop; but these items are proportionate, or nearly so, to the quantity of fruit handled.

For these reasons, and others that require no specific mention, it is difficult to satisfy an inquiring and analytical mind in response to the question, often asked, whether peach-growing is a profitable enterprise.

CHAPTER XVI

PEACH VARIETIES, BOTANY AND CLASSIFICATION

THE question of what varieties to plant presents itself in one form or another to every prospective planter of peaches. The financial success or failure of the orchard is often determined by the way in which this question is answered. There is a chance for the exercise of individual choice within certain limits and the selection of favorite varieties. The environment must be considered in the relation of its many factors to the behavior of the varieties, the market conditions that must be met, transportation facilities, and the manner in which the fruit is to be used. In many cases, the sequence of ripening is of very great importance and presents one of the most difficult problems to adjust satisfactorily, and also one concerning which adequate information is often lacking. If a grower whose entire enterprise is the production of peaches wishes to ship fruit throughout the longest possible period, it is essential that his varieties be so selected that they will give him a continuous supply of fruit. Otherwise there will be periods when his crew will have to be idle on account of breaks in the sequence of ripening; or it may be that at some periods he will have more varieties ripening at the same time than he can handle with the crew which is adequate for the greater portion of the crop. Either extreme presents a serious economic condition in the management of

the orchard. To handle the crop satisfactorily and economically, a continuous and uniform supply of fruit is essential.

While the matter of the adaptability of varieties to different conditions calls for much consideration, it is usually a factor that is less acute than with many other fruits. In other words, there are doubtless more varieties of peaches that will develop to a good degree of perfection under a wider range of conditions than is true of many other kinds of fruits. But the selection of varieties for growing in different sections that will ripen at a time when the markets are not overstocked is the real problem in this connection. Some districts owe their prominence and importance as peach-growing centers largely to the fact that some of the best market varieties ripen in these districts at times when they usually bring exceptionally large prices, because at those times relatively little fruit is being marketed from other districts. Thus a peach-grower in New Jersey may know that the Greensboro peach does well under his conditions, but that he cannot market it to advantage when there is a good crop of Elberta peaches in Georgia, though it is profitable in seasons of light crops in Georgia. Similarly the Salwey peach was formerly a profitable variety to grow in some parts of California, but in certain sections of that state it cannot now compete to advantage with the Elberta peach from Colorado. Accordingly, the Salwey peach is not found in many of the younger orchards in certain districts of California in which it was formerly a variety of considerable prominence.

The choosing of varieties for particular uses injects into the variety problem still other factors. For example, in California certain varieties are planted for canning, others for drying, still others for shipping in the fresh state. While some are dual-purpose varieties, particular adaptations to

different uses are fairly well differentiated. Those largely planted in California for canning are yellow clingstone sorts. The firm, meaty, fine grained flesh renders certain sorts of particular value for this purpose. On the other hand, those used for drying are rather dry fleshed freestone sorts. In still other respects, special adaptations are recognized.

New varieties habitually present special problems, and frequently offer peculiar temptations to growers of limited experience. Not infrequently they are introduced to the trade with extravagant claims as to their merits or value. The temptation is to accept such claims as representing the results of mature and widely developed experience when in reality the variety may not have been grown outside the region of its origin. In other words, novelties and new or little known sorts, in general, should be planted cautiously and as a rule only in sufficient quantity to test them until after their merits and adaptability to the conditions have been determined by such tests.

It may be stated in this connection also that peach varieties are regarded as self-fertile, hence it is safe to plant single varieties in large blocks if desired without the necessity of providing other sorts to insure cross-pollination — a very important provision that needs to be made in case of most apple, pear, and many plum varieties. A few growers have an impression that certain sorts of peaches fruit better when planted with other varieties which furnish means for cross-pollination, but this apparently finds little to support it in the experience of most growers.

One of the best guides for a prospective peach-grower in choosing varieties is the experience of growers already well established in the locality where the new planting is to be

PLATE XXVIII. — *Top*, a desirable orchard wagon and convenient picking-baskets; *center*, packing in the orchard in one-half bushel Delaware baskets; *bottom*, a wagon loaded with Delaware baskets.

made or in one in which the conditions are similar to those where the new orchard is to be established.

The peach varieties named in the lists below show the principal sorts that are now being grown in different sections of the United States. The approximate date when each one ripens in the sections where grown is also shown. These variety lists and the appended dates are based largely on the experience of commercial peach-growers in the different sections indicated. The ripening dates, however, though supplied by growers, should be considered in the light of several facts: There may be variations in the date of ripening of a variety in the same orchard in different years of one to two weeks or even more, due to climatic or other conditions. Very vigorous trees, as when stimulated with nitrogenous manures, will ripen their fruit later than less vigorous trees of the same variety. The sequence of ripening of varieties, especially when they normally mature rather close together, may not be the same in successive years, even in the same orchard. Moreover, the sequence may vary somewhat in different regions. Differences in elevation make wide differences in the ripening of a variety even in orchards in the same locality; the higher the elevation, the later the date of maturity. The ripening dates, therefore, while of much help in selecting varieties for planting, should be considered as relative and approximate only with regard to any one season, rather than as absolute and definitely fixed occurrences.

With these precautions, the following lists should prove helpful to the prospective planter. The arrangement of the lists is alphabetically by states. The region to which each list applies is indicated by the name of an important peach center or district, together with the general section of the

state in which it is located and as nearly as possible the elevation of the principal orchard sites. The varieties are named in the lists as nearly as possible in the sequence in which they ripen.

TABLE XIII. — LISTS OF PEACH VARIETIES AND APPROXIMATE DATES OF FIRST RIPENING AS GROWN IN IMPORTANT COMMERCIAL DISTRICTS THROUGHOUT THE UNITED STATES

Alabama

Atmore (South central, elevation 300 feet)

Mayflower	May 25 to June 1
Arp (*Arp Beauty*)	June 1 to June 5
Greensboro	June 1 to June 5
Carman	June 3 to June 15
Early Elberta	June 10 to June 20
Belle	June 15 to July 1
Elberta	July 1 to July 20

Arizona

Thatcher (Southeast, Gila Valley, elevation 3000 feet)

Mayflower	June 10
Early Elberta	July 20
Chinese Cling	July 25 to 31
Elberta	August 1

Tempe (Central, elevation 1200 feet)

Alexander
Early Wheeler (*Red Bird Cling*)
Tuskena (*Tuscan*)
Lovell
Phillips
Salwey

In the Southern Valleys [1]

Alexander
Dewey
St. John
Briggs

[1] Ariz. Expt. Sta. Bull. 78, "Relations of Weather Crops and Varieties adapted to Arizona Conditions."

Belle
Elberta
Late Crawford
Wheatland
Krummel
Sylphide
Salwey

Arkansas

Highland (Southwest, elevation 500–600 feet)

Early Wheeler (*Red Bird Cling*)	June 15 to 20
Elberta	July 10

Van Buren (West central, elevation 400–450 feet)

Early Wheeler	June 5 to 10
Carman	
Mamie Ross	
Elberta	July 15

Springdale, Harrison (Northwest, elevation 1000–1300 feet)

Early Wheeler	July 1
Slappey	July 15
Champion	July 25
Elberta	July 25 to August 10

California

Ontario [1] (Southern, elevation 1000 feet)

Elberta	July 12 to 20
Tuskena (*Tuscan*)	July 12 to 20
Muir	
Lovell	
Phillips	

Hanford [2] (Central, elevation 250–300 feet)

Elberta	July 15
Tuskena (*Tuscan*)	July 25

[1] These varieties are used mostly for canning.

[2] This list represents the principal varieties grown in the San Joaquin Valley, one of the important peach districts of California. The time of ripening varies from 10 to 20 days, depending on the location in this valley. The dates given are for a relatively early location. The Elberta, Muir, and Lovell are used principally for drying; the Tuskena, Orange Cling, and Phillips, for canning.

Muir	July 25
Orange Cling	August 1
Lovell	August 1
Phillips	September 1

Vacaville[1] (Central-Sacramento Valley, elevation 175–200 feet)

Alexander	May 15 to June 1
Triumph	June 1 to June 10
Early Hale	June 10 to July 20
St. John	June 15 to July 1
Foster	July 1 to July 10
Early Crawford	July 1 to July 10
Elberta	July 1 to July 10
Decker	July 5 to July 15
Late Crawford	July 25 to August 1
Susquehanna	August 1 to August 10
Salwey	August 15 to August 25

Yuba City (Central-Sacramento Valley, elevation 70 feet)

Tuskena (*Tuscan*)	July 15 to August 1
Johnson	August 1 to August 15
Hauss	August 1 to August 15
Walton	August 1 to August 15
Albright Cling	August 10 to August 25
Muir[2]	August 15 to August 30
Lovell[2]	September 1 to September 15
Phillips	September 1 to September 15

Newcastle and East Auburn (Central, foot hills, elevation 1000–1400 feet)

Mayflower	May 25 to June 10
Alexander	June 8 to 10
Triumph	June 12 to 30

[1] Vacaville is one of the "earliest" districts in California, hence one of the first in the season to begin the shipping of fresh fruits. Formerly the early ripening varieties of peaches were much grown here, but in recent years the Elberta has become the principal shipping variety.

[2] Used largely for drying but also for canning; other varieties in the list are grown for canning.

Early Hale	June 18 to July 6
St. John	June 28 to July 15
Early Crawford	July 10 to 27
Foster	July 15 to 31
Strawberry	July 15 to 31
Elberta	July 25
Late Crawford	July 25 to August 13
Tuskena	
Hauss	
Muir	July 27 to August 15
Hale (J. H.)	August 5 to August 20
Lovell	August 5 to August 30
Phillips	August 25
Salwey	August 25 to September 15
Levy	
Sherman	October 1

Colorado

Palisades (West central, Grand Valley, elevation 4750 feet)

Alexander	
Carman	
Elberta [1]	August 20 to 31
Orange Cling	
Heath	

Paonia (West central, elevation 5700 feet)

Greensboro	August 5 to 10
Triumph	August 7 to 16
Carman	August 12 to 26
Early Crawford	August 28 to September 8
Elberta [1]	September 1 to 10
Fitzgerald	September 12 to 20

Connecticut

Greenwich and Wallingford (Southwest, elevation 30–75 feet)

Greensboro	August 3
Carman	August 12

[1] This is the only variety grown in large quantities.

Hiley	August 20
Champion	August 20
Belle	August 27
Elberta	September 1
Hale (J. H.)	September 1
Stump	September 5
Late Crawford	September 12
Fox	September 15
Iron Mountain	September 25

Yalesville and Middlefield (Central, elevation 100–250 feet)

Greensboro	August 1 to 10
Nectar	August 10
Carman	August 15 to 20
Hiley	August 25 to September 1
Belle	September 1 to 5
Champion	September 1 to 10
Elberta	September 5 to 10
Frances	September 10 to 15
Stump	September 15
Fox	September 20 to 25
Stevens	September 25 to 30
Salwey	October 15

South Glastonbury (Central, elevation 300–400 feet)

Greensboro	July 23
Early Rose	July 29
Carman	August 10
Hiley	August 28
Belle	August 28
Champion	August 28
Hale (J. H.)	August 30
Elberta	September 1

Delaware

Wyoming (Central, elevation 40 feet)

Belle	August 10 to 20
Hale (J. H.)	August 18 to 25
Elberta	August 20 to 30

Florida

Umatilla, Deland, Seville, and adjacent sections (East central to northeast, elevation 50–70 feet)

Jewel	May 1 to 15
Waldo	May 8 to 20
Angel	
Late Bidwell	

Georgia

Fort Valley (Central, elevation 525 feet)

Mayflower	May 25 to June 5
Greensboro	June 1 to June 10
Early Rose	June 10 to June 18
Carman	June 20 to June 30
Hiley	July 1 to July 12
Belle	July 10 to July 18
Hale (J. H.)	July 12 to July 25
Elberta	July 15 to July 25

Cornelia (Northeast, elevation 1600–1700 feet)

Carman	June 25 to July 4
Belle	July 20 to July 31
Elberta	July 25 to August 3

Idaho

Snake River Valley region (Southwest, elevation 2000–2500 feet)

Sneed	June 25
Alexander	July 4
Triumph	July 22
Early Hale	August 1
Champion	August 20
Elberta	August 25
Salwey	September 25

Lewiston (Northwest, elevation 800 feet)

Triumph	July 10 to 15
Early Hale	July 15 to 20

Early Crawford	July 25 to 30
Elberta	August 1
Late Crawford	August 1
Foster	August 5
Muir	August 10 to 15
Salwey	September 1 to 5

Illinois

Centralia and Southern Illinois (elevation, 500–600 feet)

Early Wheeler (*Red Bird Cling*)	July 15
Triumph	July 20
Waddell	July 25
Carman	August 10
Illinois	August 10
Minnie (*Alton*)	August 10
Early Crawford	August 10
Champion	August 15
Belle	August 18
Ede	August 18
Thurber	August 18
Family Favorite	August 18
Hale (J. H.)	August 20
Elberta [1]	August 20
Matthews	August 30
Late Crawford	September 8
Beers Smock	September 10
Heath	September 25
Salwey	October 5
Levy	October 10

Indiana [2]

(Central, elevation 700 feet)

Greensboro *	July 25
Dewey	August 10

[1] Elberta is estimated to be 90 per cent of the total.

[2] List from Ind. Expt. Sta. Circ. 69, "Peach Growing in Indiana." Varieties indicated with an asterisk (*) are suitable for commercial planting.

Carman *	August 12
Mountain Rose	August 15
Fitzgerald	August 20
Early Crawford	August 20
Champion *	August 25
Belle *	September 1
Reeves	September 3
Elberta *	September 5
Prolific	September 5
Kalamazoo	September 10
Oldmixon Free	September 10
Late Crawford	September 15
Crosby *	September 15
Gold Drop	September 20
Smock	September 20
Salwey *	September 25

Mitchell (South central, elevation 700 feet)

Champion	August 1 to 10
Belle	August 1 to 10
Elberta	August 10 to 20

Iowa

Mt. Pleasant (Southeast, elevation 730 feet)

Alexander	July 25
Triumph	August 1 to 15
Champion	August 15 to 31
Elberta	August 25 to 31

Kansas

Medicine Lodge (South central, elevation 1475 feet)

Sneed	June 18
Alexander	July 4
Carman	August 1
Minne (*Alton*)	August 1
Champion	August 15 to 20
Belle	August 25
Elberta	August 25 to 30
Hale (J. H.)	September 1 to 10
Wonderful	October 10

Salwey	October 10
Heath	October 10 to 15
Levy (*Henrietta*)	October 20 to 25

Kentucky

Bowling Green (South central, elevation 500–550 feet)

Alexander	July 1
Carman	July 15 to 20
Champion	August 1
Elberta	August 8 to 10
Late Crawford	
Stump	
Heath Free	
Heath	
Levy	

Louisiana

Plain Dealing (Northwest, elevation 275 feet)

Elberta	July 10

Maryland

Salisbury (Southeast, elevation 25 feet)

Greensboro	July 11
Carman	July 24 to 28
Champion	July 31 to August 8
Ray	August 10 to 15
Belle	August 12
Hale (J. H.)	August 15
Elberta	August 19
Frances	August 24

Boonsboro and Western Maryland (elevation 500–750 feet)

Greensboro	July 15
Carman	July 25 to August 10
Slappey	August 1 to August 10
Champion	August 1 to August 15
Belle	August 10 to August 20
Oldmixon Free	August 15 to August 25
Ray	August 15 to August 20

Elberta	August 20 to September 1
Late Crawford	September 1
Chairs	September 1
Stevens	September 5 to 15
Beers Smock	September 5 to 15
Smock	September 10 to 20
Geary	September 10 to 20
Salwey	September 10 to 30
Bilyeu	October 1 to 10

Massachusetts

Wilbraham, Grafton (South central, elevation 300–550 feet)

Greensboro	July 27 to August 1
Waddell	August 8
Carman	August 12 to 15
Mountain Rose	August 15
Champion	August 15 to 30
Hiley	August 20
Belle	August 25
Hale (J. H.)	September 5 to 8
Elberta	September 8 to 10
Fox	September 20
Iron Mountain	September 20 to 25
Krummel	October 10 to 25

Ipswich (Northeast, elevation 25 feet)

Greensboro	August 5
Waddell	August 15
Carman	August 18
Champion	August 25
Mountain Rose	August 25 to 30
Hiley	August 28
Belle	September 5 to 10
Fitzgerald	September 8
Oldmixon Free	September 10 to 12
Kalamazoo	September 15 to 20
Elberta	September 15 to 20
Crosby	September 20
Stump	September 20 to 25
Chairs	September 25 to 30
Stevens	October 1

Michigan

Lake Region (Southwest, elevation 600 feet)

Carman	August 10 to 15
Dewey	August 15
Lewis	August 15 to 20
St. John	August 25 to 30
Champion	August 28
Engle	August 28 to September 10
Kalamazoo	September 1 to 10
New Prolific	September 1 to 8
Belle	September 1
Fitzgerald	September 1 to 8
Elberta	September 5 to 15
Gold Drop	September 12 to 25
Lemon Free	September 15 to 25
Beers Smock	September 15 to 25
Smock	September 20 to 25
Salwey	September 20 to October 5

Missouri

Koshkonong (South central, elevation 975 feet)

Elberta	August 1

Cedar Gap (South central, elevation 1700 feet)

Carman	July 15
Champion	August 10
Elberta	August 15 to 20
Salwey	September 25

New Hampshire

Wilton (South central, elevation 350 feet)

Greensboro	
Waddell	
Carman	August 20
Mountain Rose	September 9
Belle	September 12
Champion	September 12
Oldmixon Free	September 14

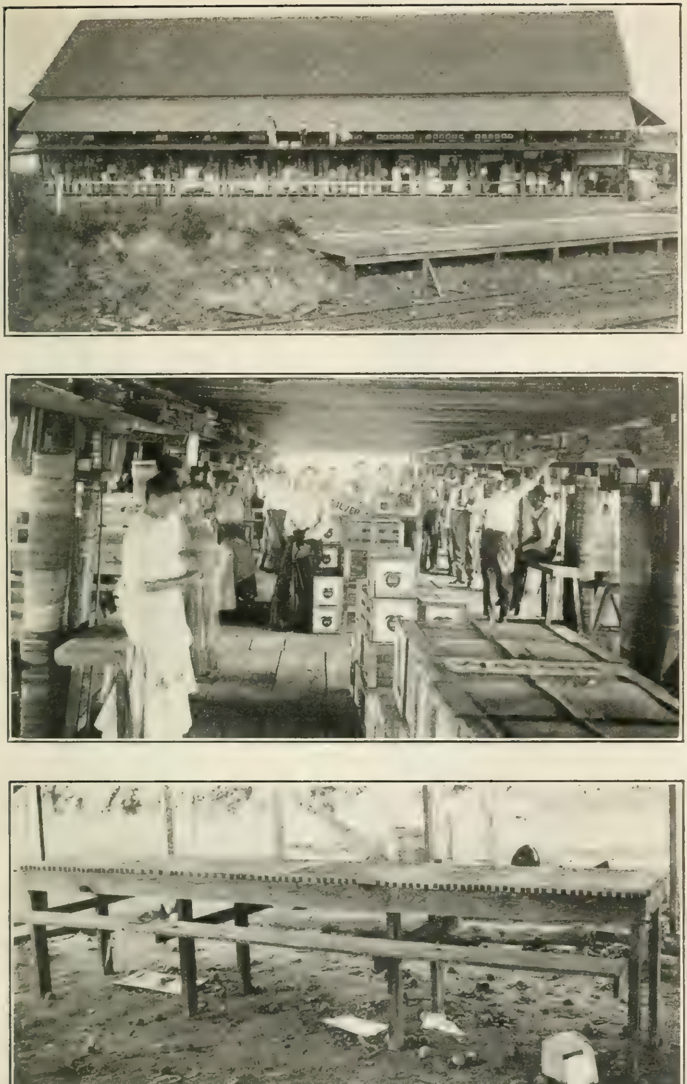

Plate XXIX. — Packing Houses and Equipment. *Top*, exterior view; *center*, interior view; *bottom*, a canvas-topped packing-table.

Elberta	September 15 to 25
Stump	September 20
Late Crawford	September 25 to 30

New Jersey

Hammonton and southern New Jersey (elevation 100–120 feet)

Greensboro	July 20 to August 1
Carman	August 1 to 10
Connet	August 1 to 10
Hiley	August 10
Champion	August 20
Belle	August 20
Elberta	August 25 to September 5
Late Crawford	September 1
Late Stump	September 10

Marlton (West central, elevation 100 feet)

Greensboro	July 15
Waddell	August 1
Carman	August 1
Champion	August 10
Belle	August 20
Elberta	August 25
Frances	September 5
Fox	September 10
Iron Mountain	September 15
Krummel	October 10

New Mexico

State College (South central, elevation 3500–4000 feet)

Mayflower	June 1 to 7
Alexander	June 24 to 29
Hynes	July 10 to 15
Carman	July 20 to 25
Mamie Ross	July 20 to 25
Texas King	July 20 to 25
Elberta	August 1 to 8
Late Crawford	August 10 to 15
Salwey	September 15 to 20

Farmington (Northwest, elevation 6000 feet)

Alexander	July 11 to 26
Triumph	July 19 to August 2
Carman	August 15 to 31
Champion	August 25 to 31
Elberta	September 1 to 10

New York

Middle River (Southeast, Long Island, elevation 75 feet)

Greensboro	August 1
Carman	August 12 to 15
Mountain Rose	
Champion	
Belle	
Oldmixon Free	
Elberta	September 20
Stump	
Fox	
Iron Mountain	

Marlboro (Southeast, Hudson Valley, elevation 300–400 feet)

Greensboro	July 20 to 31
Carman	August 1
Champion	August 15 to 25
Elberta	August 20 to September 5
Iron Mountain	September 25
Salwey	October 1

Lake Region (Western New York, elevation 450–525 feet)

Carman	August 20 to September 1
St. John	August 25 to September 5
Early Crawford	August 28 to September 10
Rochester	September 1 to 10
Niagara	September 5 to 15
Reeves	September 5 to 15
Champion	September 5 to 15
Elberta	September 10 to 20
Smock	September 30 to October 15

North Carolina

Southern Pines (South central, elevation 500 feet)

Mayflower	May 25
Alexander	June 10
Yellow Swan	June 10
Carman	July 1
Belle	July 20
Elberta	July 25

Manteo (East, Roanoke Island, elevation 10 to 15 feet)

Mayflower	June 10
Greensboro	June 25
Carman	July 10
Niagara	July 25
Champion	July 25
Elberta	August 10

A more extended list in order of ripening in central North Carolina:

Mayflower
Victor
Alexander
Arp
Yellow Swan
Greensboro
Early Wheeler (*Red Bird*)
Carman
Connet
Briggs
Hiley
Niagara
Belle
Ray
Elberta
Johnson
Munson Free
Crothers
Augbert

Ohio

Port Clinton and Lake Shore Region (North central, elevation 600 feet)

Carman	August 15
New Prolific	August 25
Elberta	August 25 to September 1
Lemon Free	September 12 to 18
Beers Smock	September 20
Smock	September 22 to 25
Salwey	October 1 to 10

Oklahoma

Perry (North central, elevation 1000 feet)

Mayflower	June 20
Japan Dream	June 30
Triumph	July 1
Carman	July 10
Mamie Ross	July 10
Champion	July 20
Early Crawford	July 25
Belle	July 30
Elberta	August 10
Late Crawford	August 15
Chinese Cling	August 20
Heath	September 15
Blood Cling	September 20

Oregon

Freewater (Northeast, elevation 1000 feet)

Arp	July 6 to 17
Grady	July 6 to 17
Triumph	July 11 to 20
Early Crawford	July 29 to August 14
Elberta	August 17 to 29
Salwey	September 24 to October 1

The Dallas (North central, elevation 100 to 300 feet)

Mayflower	June 20
Alexander	July 8

Triumph	July 25
Early Hale	July 25
Early Crawford	August 15
Elberta	September 1
Late Crawford	September 10
Salwey	October 1

Ashland (Southwest, elevation 2000 feet)

Alexander	July 14 to 17
Early Hale	July 30 to August 3
Early Crawford	August 10 to 15
Elberta	August 20 to 22
Late Crawford	September 1 to 3
Muir	September 1 to 5
Salwey	September 25 to October 1
Krummel	October 10 to 12

Pennsylvania

Southern and southeastern counties (elevation, 200 to 700 feet)

Greensboro	August 1
Carman	August 10
Champion	August 15 to 20
Mountain Rose	August 15 to 20
Belle	August 15 to 20
Ray	August 15 to 20
Oldmixon Free	August 25
Reeves	August 25
Elberta	September 1
Fox	September 10
Stevens	September 15
Smock	September 20
Wonderful	September 25
Iron Mountain	September 25
Heath	September 28
Salwey	October 1
Bilyeu	October 10

Waymart (Northeast, elevation 1400 to 1500 feet)

Greensboro	August 15
Carman	August 23
Champion	September 20

Belle	September 22
Fitzgerald	September 30
Elberta	October 1

South Carolina

Meriweather (West central, elevation 300 feet)

Mayflower	May 20 to 25
Greensboro	
Early Wheeler (*Red Bird Cling*)	
Carman	
Hiley	
Belle	
Elberta	July 10

Ridge Springs (West central, elevation 650 feet)

Mayflower	May 30
Greensboro	June 5 to 20
Hiley	June 30 to July 10
Belle	July 10 to 20

Tennessee

Sale Creek (Southeast, elevation 750 feet)

Carman	July 1
Belle	July 10
Elberta	July 15 to 18

Texas

Tyler, Scottsville (Northeast, elevation 400–550 feet)

Greensboro	June 5 to 8
Carman	June 22 to 26
Hiley	June 22 to July 3
Mamie Ross	June 22 to July 3
Slappey	June 22 to July 3
Belle	July 1 to 8
Elberta	July 2 to 10
Augbert	July 20

Mexia (East central to northeast, elevation 540 feet)

Victor [1]	May 25 to 31
Swan	
Arp	
Carman [1]	July 1 to 10
Elberta	July 20
Tena	July 20
Anita	July 25 to 30
Toughina	August 1 to 10
Lizzie	August 15 to 20
Frank	August 20 to 25
Barbara	August 22 to 28
Katie	August 24 to September 6

Utah

Ogden, Brigham, Springville (North central, elevation 4300–4600 feet)

Alexander	July 20
Early Wheeler	August 1
Early Hale	August 10
Triumph	August 15
La Grange	August 20
Foster	August 20
Early Crawford	August 20
Chinese Cling	August 25
Champion	August 25 to 30
Early Elberta	September 1
Elberta [2]	September 5 to 10
Globe	September 10
Orange Cling	September 12 to 20
Phillips	September 15 to 20
Sellers	September 15 to 20
Heath	September 20

[1] Victor and Carman only white-fleshed varieties in this list. All others have yellow flesh.

[2] The Elberta comprises a very large proportion of the commercial crop.

Virginia

Staunton (West central, elevation 1400 feet)

Champion	July 25 to 31
Elberta	August 15
Late Crawford	September 15
Krummel	October 1

Washington

Yakima and Wenatchee Valleys[1] (Central, elevation 650–1100 feet)

Dewey	July 20 to August 5
Carman	July 25 to August 1
Early Elberta	August 5 to 20
Slappey	August 8 to 28
Early Crawford	August 10
Elberta	August 15 to 30
Late Crawford	September 1 to 10
Salwey	September 20 to October 10

West Virginia

Allegheny Mountain Sites, Potomac Valley region[2] (Northeast, elevations 1000–2000 feet)

Carman	July 28
Connet	August 1
Hiley	August 10

[1] This list includes the most of the varieties planted in the several peach-producing valleys of Washington. The dates of ripening vary somewhat depending on the conditions in the different sections, both in the same and different valleys. The Elberta is the main crop.

[2] In the region covered by this list the aim of most peach-growers is to ship continuously throughout the season from the last of July, when the shipments from the large southern peach districts cease. The list includes the varieties largely planted for this purpose. Obviously the exact time of ripening of the different varieties is influenced by elevation and other local conditions. The dates given represent as nearly as it is possible to make them about an average for the region.

Champion	August 10
Belle	August 15
Oldmixon Free	August 18
Elberta	August 20
Late Crawford	August 30
Chairs	August 30
Stevens	September 5
Walker	September 5
McCollister	September 10
Beers Smock	September 15
Smock	September 20
Levy	September 25
Heath	September 25
Salwey	September 25
Bilyeu	October 10

Attention has been called previously to the relative importance and wide distribution of the Elberta variety. It is to be observed that nearly all the foregoing lists include this sort, and although the fact is not brought out, in many of the localities represented in the lists the Elberta comprises the bulk of the fruit grown for commercial purposes. In not a few sections it is practically the only variety shipped.

The Carman, Belle, and Champion are other sorts especially to be named as being very widely and extensively planted at the present time.

VARIETAL CHARACTERISTICS

In selecting varieties for planting, there are two characteristics of particular importance in comparison with others which a grower desires to consider: the color of the flesh and its adhesion to the pit, that is, whether it clings to the pit (clingstone) or whether it separates freely (freestone) from it.

While detailed varietal descriptions would serve but little practical purpose in this connection, a statement of these two important characteristics for the varieties that are most commonly planted is worth while. The following list is made up of the varieties named above in the regional lists, arranged alphabetically and with the color of flesh and adhesion indicated. The following abbreviations are used:

W = a white-fleshed variety;
Y = a yellow-fleshed variety;
C = a clingstone;
F = a freestone.

Since some varieties are intermediate in adhesion, neither tightly clinging nor separating freely, and some varieties are variable under different conditions, the combination C F is used to indicate such sorts. The combinations used in other respects are self-explaining.

Table XIV. — Leading varieties with important characteristics indicated

Albright Cling	Y	C	
Alexander	W	C	F
Angel	W	F	
Anita	Y	F	
Arp	Y	C	F
Augbert	Y	F	
Barbara	Y	F	
Beers Smock	Y	F	
Belle	W	F	
Bilyeu	W	F	
Blood Cling [1]		C	
Briggs	W	F	

[1] The flesh is reddish in color.

PLATE XXX. — PEACH PACKAGES AND DIFFERENT STYLES OF PACKS.
Top, Georgia 6-basket carriers; *bottom*, 20-pound boxes.

Carman	W C F
Chairs	Y F
Champion	W F
Chinese Cling	W C
Connet	W C F
Crosby	Y F
Crothers	W F
Decker	W F
Dewey	Y F
Early Crawford	Y F
Early Elberta	Y F
Early Hale	W C F
Early Rose	W C
Early Wheeler	W C
Ede	Y F
Elberta	Y F
Engle	Y F
Family Favorite	W F
Fitzgerald	Y F
Foster	W F
Fox	W F
Frances	Y F
Frank	Y C
Geary	Y F
Globe	Y F
Gold Drop	Y F
Grady	Y F
Greensboro	W C F
Hale (J. H.)	Y F
Hauss	Y C
Heath	W C
Heath Free	W F
Hiley	W F
Hynes	W C F
Illinois	W F
Iron Mountain	Y C F

Japan Dream [1]	F
Jewel	Y F
Johnson	Y F
Kalamazoo	Y F
Katie	Y F
Krummel	Y F
La Grange	Y F
Late Bidwell	W C
Late Crawford	Y F
Late Stump	Y F
Lemon Free	Y F
Levy	Y C
Lewis	W F
Lizzie	Y F
Lovell	Y F
McCollister	Y F
Mamie Ross	W C F
Mathews	Y F
Mayflower	W C F
Minnie (*Alton*)	W F
Mountain Rose	W F
Muir	Y F
Munson Free	Y F
Nectar	Y C F
New Prolific	Y F
Niagara	Y F
Orange Cling	Y C
Phillips	Y C
Ray	W C F
Reeves	Y F
Rochester	Y F
St. John	Y F
Salwey	Y F
Sellers	Y C
Sherman	Y W C

[1] Flesh is blood-red.

Slappey	Y F
Sneed	W C
Strawberry	W F
Stevens	W F
Stump	W F
Susquehanna	Y F
Tena	Y F
Texas King	Y C F
Thurber	W F
Toughina	Y F
Triumph	Y F
Tuskena (*Tuscan*)	Y C
Victor	W C F
Waddell	W F
Waldo	Y W F
Walker	W F
Walton	Y C
Wonderful	Y F
Yellow Swan	Y F

AN INVENTORY OF VARIETIES

While an inventory of the peach varieties that are being offered to the growers of America may be of little practical value to the peach industry at the present time, it is not without interest. As a matter of record, a list of the varieties that are being propagated in the nurseries at any particular time is of value for historical reasons.

It is practically impossible to make such a list absolutely complete. There are many local varieties propagated in a small way, the names of which are never published in a catalogue. There are also many small nurseries doing a local business which publish merely brief trade lists that are not widely circulated. However, an inventory of varieties based on the catalogues of a large number of representative

nurseries throughout the country including all the larger ones and many of those whose principal activities are local in their scope, must obviously be reasonably complete. The results of an inventory so based are given below. The list shows the varieties offered by nurserymen for the season of 1916 and contains 417 names. The names as given have been conformed as far as possible to the rules of nomenclature of the American Pomological Society:

Acampo, Ada Lyle, Albright, Alexander, Amanda, Ambrosia, Amelia, Amsden, Anderson, Angel, Argyle Elberta, Arkansas, Arp, Augbert, Aurora, Australian Saucer.

Bailey, Baldwin, Banner, Barbara, Barnard, Barnes, Beatrice, Beers Smock, Belle, Bell October, Bequette Cling, Bequette Free, Berckmans, Berenice, Bessie Kerr, Bilyeu, Bishop, Blanchard, Blood Cling, Blood-leaved, Blush, Bokhara, Bonanza, Brackett, Bradbury, Brandywine, Brewer, Brigdon, Briggs May, Bronson, Buckhorn, Burke, Burton, Bustain, Butlers.

Cabler, California, Camilia, Canners Choice, Carman, Carpenter, Carson, Caruth, Chairs, Champion, Charlotte, Chili, Chinese Cling, Chinese Free, Christiana, Chilow, Chisolm, Cleveland Free, Climax, Colon, Colquitt, Columbia, Comal, Cone Johnson, Conkling, Comet, Cook, Coolidge, Cornwall (*Duchess of Cornwall*), Countess, Crane, Crosby, Crothers.

Daisy, Decker, Deming, Denton, Dewey, Dixie, Dorothy, Druid Hill, Duke of York.

Early Admirable, Early Bidwell, Early Canada, Early Columbia, Early Crawford, Early Elberta, Early Hale, Early Husted, Early Imperial, Early Michigan, Early Rose, Early Wheeler (*Red Bird Cling*), Early York, Easton, Eaton, Ede, Edgemont, Elberta, Elberta Cling, Elberta (Hottes), Ella Hord, Ellington, Emma, Engle, Estella, Eureka, Everbearing.

Family Favorite, Fitzgerald, Fleener, Florida, Florida Gem, Fords, Foster, Fox, Frances, Frank, Future.

Garfield, Garland (*Gov. Garland*), Geary, George IV, Georges Late, Georgia Press, Gibbons, Gillingham, Gladstone, Glen, Globe, Gold Drop, Gold Dust, Gold Mine, Golden, Golden Cling, Golden Mammoth, Golden Swan, Golden Sweet, Goldfinch, Governor Hogg, Grace, Great Eastern, Greensboro, Grimes, Grosse Mignonne.

Hale (J. H.), Hance, Hancock, Harrison (*General Harrison*), Harrison Cling, Hauss, Heath, Heath Free, Heckel, Hero, Hester, Hiley, Hobson, Holderbaum, Honest John (May be Large York or George IV), Honey, Hoosier Cling, House, Hughes, Hynes, Hyslop.

Idaho Mammoth, Illinois, Imperial, Indian Cling, Indian Free, Ingold, Iron Mountain.

Jackson, Japan Blood, Japan Dream, Jaques, Jellico, Jennie Worthen, Jennings, Jewel, Johnson, June Elberta, June Rose, June, Justice.

Kalamazoo, Kelly, Kennesaw, Kent, Kerr, Keyport, Kihlken, Klondike, Krummel, Kruse.

Lamont, Lane, Large York, Large White, Late Bidwell, Late Crawford, Late Elberta, Late Ford, Late Miller, Late Quality, Leader, Lee, Lee Cling, Leigh, Lemon Cling, Lemon Free, Leona, Levis, Levy, Lewis, Libby, Lindsay, Lockwood, Lola, Lone Tree, Longhurst, Lorentz, Louise, Lovell, Lovetts Early White, Luton, Luttichau, Lyndon.

McCollister, McCoy Free, McDevitt, McKevitt, McNeil, Magnum Bonum, Malcom, Malcom Everbearing, Mamie Ross, Mammoth Cling, Marshall, Martha Fern, Martin September, Mary (*Marys Choice*), Marys Choice (Red), Mathews, Mayflower, May Lee, Mealing, Mellie, Michigan Chili, Mikado, Millard, Millen, Miller, Millionaire (May be Hale (J. H.)), Minnie (*Alton*), Moore, Morris Red, Morris White, Mountain Rose, Muir, Munson, Munson Free.

National, Nancy, Newhall, New Prolific, Niagara, Nettie Corbet, Nichols, Nina, November, November Heath.

Oceana, October Elberta, Oklahoma, Oklahoma Queen, Old-

mixon Cling, Oldmixon Free, Onderdonk, Opulent, Orange Cling, Oriole.

Palestine, Pallas, Palls, Palmerston, Patterson, Peak, Pearce, Peen-to, Peerless, Pendleton, Peregrine, Perfection, Plant, Phillips, Picquet, Pineapple, Pond, Powers, Preston, Prince of Wales, Prolific.

Raisin, Ray, Red Rareripe, Red Cheek, Red River, Reeves, Rex, Richards, Ringgold, Rivers, Robert, Robins, Rochester, Rogers, Royal George, Ruding, Runyon, Rupley, Russell.

Sabichi Winter, St. John, Sallie Worrell, Salwey, Schumaker, Sea Eagle, Sellers, Shamrock, Sims, Sims Cling, Skinner, Slappey, Sleeper, Smith, Smith Cling, Smithson, Sneed, Snow Cling, Snow Orange, Steadley, Stearns, Stinson, Stonewall, Strawberry, Strout, Stump, Suber, Success, Summer Heath, Summerour, Sunrise, Superb, Susquehanna, Swan, Sylphide.

Taber, Tarbell, Texan, Texas, Thurber, Tibout, Tillotson, Tippecanoe, Tornado, Triana, Troth, Triumph, Tryon, Tuskena, Twenty Ounce.

Van Buren, Van Deman, Victor, Victoria.

Waddell, Wager, Waldo, Waller, Walker, Walton, Ward, Washington, Waterloo, Weed, Wellington, Wheatland, Whitford, Wilbur, Wilkins, Willett, Wine, Winifred, Wonderful, Worlds Fair, Worth, Wright.

Yellow Hall, Yellow Rareripe, Yates, Yellow Swan.

Zip.

BOTANY OF THE PEACH

The peach has been known to botanists under various names, depending mostly on the genus to which it is referred. Linnæus, in 1753, placed it in the genus Amygdalus, calling the species *Amygdalus Persica.* Fifteen years later Philip Miller placed it in the separate genus Persica, under the name *P. vulgaris.* Most botanists, however, have preferred to include it in the genus Prunus, with the plums and apricots;

under this disposition it takes the name *Prunus Persica*. The use of the word *Persica* doubtless reflects the views of the early botanists regarding the origin in Persia of the peach; in fact, the word peach itself (pêcher in French, *Pfirsich* in German) is derived from the word Persia.

Though it is the usual assumption that all horticultural varieties of peaches represent but one botanical species, it is by no means certain that a critical investigation might not reveal evidence showing that several distinct species have entered into our horticultural varieties. The line or lines of development are obviously obscured by lack of definite information concerning the wild forms in their native habitats.

The almond is a close botanical relative of the peach. In fact, at one time it was thought by some that the peach is derived from the almond; others looked on the almond as having developed from the peach, but these hypotheses are no longer maintained. The apricot is less closely related to the peach than the almond, while nectarines (which are smooth skinned peaches) are known definitely to develop from peaches as sports, mutations, or bud variations. Trees bearing nectarines have been known to grow from peach pits; a peach tree occurs at rare intervals on which a limb habitually bears nectarine fruits; and even an individual fruit distinctly peach on one side and as evidently nectarine in character on the other has been known to develop on a tree. Yet notwithstanding these clear origins, it is not impossible that there exists a wild species of nectarine.

If the peach is held in the genus Prunus (rather than in Amygdalus), its synonymy becomes as follows:

PRUNUS PERSICA, Sieb & Zucc.
Amygdalus Persica, Linn.
Persica vulgaris, Mill.

Var. PLATYCARPA, Bailey (Flat peach).
Persica platycarpa, Decne.
Var. NUCIPERSICA, Schneid (Nectarine).
Amygdalus Persica var. *nucipersica*, Linn.
Persica nucipersica, Borkh.
Persica lævis, DC.
Prunus Persica var. *lævis*, Gray.
Amygdalus nectarina, Ait.
Prunus Persica var. *necturina*, Maxim.

CLASSIFICATION OF PEACHES

The earlier writers on the peach in America gave some attention to classifying peach varieties; but for the most part it consisted in dividing them into two groups, the division being based solely on the adhesion or non-adhesion of the flesh to the pit, thus recognizing a "clingstone" group and a "freestone" group. Such a division, though having its practical and useful aspects, is entirely arbitrary, and shows no natural relationships or lines of development, and this character is not constant in all cases. As a logical system of classification, grouping on this basis has long since ceased to be considered, but as indicated it has practical value and in this direction Mackintosh [1] has developed the scheme of grouping farther than any one else. He uses other physical characteristics as well as adhesion of flesh to pit, including color of flesh and season of ripening. He recognizes three main sections, freestones, clingstones, and semi-clingstones. Each of these sections is separated into two divisions based on color of flesh, varieties with white or creamy flesh and those with yellow flesh. In turn, each of these divisions is subdivided on the basis of season of ripening, varieties that

[1] An. Rept. Pa. State Col. for 1910–1911, pp. 569–588.

ripen before Elberta and those ripening with or later than that variety. A great number of varieties are listed and grouped on the basis of this classification.

The first, and in fact the only, really constructive effort to work out a classification of peach varieties along natural lines of demarcation was made by Gilbert Onderdonk who now for more than sixty-five years has lived in southern Texas, going there from New York as a young man but little more than twenty years of age. He was over eighty years of age when the picture shown in Plate XXVI was taken. This classification made by him was published as a part of the report of the pomologist in the Annual Report of the Commissioner of Agriculture (now the United States Department of Agriculture) for 1887, Onderdonk then being a special agent for the Division of Pomology.

In his observation in Texas of the behavior of peaches, particularly of trees which grew from pits carried into the state from different parts of the North, Onderdonk became impressed with the fact that differences existed, essentially basic in character, and which were correlated with the sources of origin. This view was strengthened when he observed that all the trees brought from the North into southern Texas, as well as those that grew from northern pits, made only a lingering growth and died after a few years without producing fruit in any quantity. Coupled with these observations was the discovery that trees coming from sources in Mexico not only lived and thrived, but produced fruit regularly and abundantly.

In due course Onderdonk assembled and grew for study peach trees or peach pits from all possible sources. It is unnecessary here to give in detail the course of his investigations further than to state that as a result of his studies he divided

peaches into the five groups or races which have since been the accepted basis of classification. These races are: (1) Peen-to; (2) South China; (3) Spanish; (4) North China; and (5) Persian.

The basis of this classification or grouping is, therefore, primarily regional, each race tracing to certain regions for its origin. While it may be a more or less artificial system and one which may eventually be superseded by some other, it has served a most useful purpose both for practical reasons and in the systematic work that has been done thus far with this fruit. Though there have been several slight modifications of it, especially as to the names of the races, the system of classification now recognized and used remains essentially the "Onderdonk system."

The significance of the different races, as indicated by Onderdonk, is as follows:

Peen-to race.

This race traces its origin to an importation of seed from Australia made in 1869 by the late P. J. Berckmans of Augusta, Georgia. From this collection of seed there came a peach which was distinct in its characteristics from all others. This became the Peen-to variety, from which the race takes its name, and which has given rise to a well-defined though small group of peaches which are essentially subtropical in their range of adaptability. There are between twenty and thirty varieties in this group that have been known more or less to the trade, all of which according to Hume[1] have originated in Florida. It is in Florida that these varieties are of special value, though they may be grown in other parts of the Gulf Coast region. They cannot be

[1] Fla. Expt. Sta. Bull. 62, "The Peen-to Peach Group."

grown successfully as far north as Augusta, Georgia, where the Peen-to, the progenitor of this race, proved a failure.

Of this race, the Jewel and Waldo varieties are the most important commercially. Some of the better-known varieties, beside those named, include the Angel, Early Bidwell, Late Bidwell, Hall, Suber, and others.

South China race.

This race began in the United States with the Honey[1] variety, by which name the race is now commonly designated. According to Onderdonk, Charles Downing of New York obtained peach pits from China some time prior to 1855. Reimer gives the year as 1846. From one of these the original Honey tree grew. This one tree appears to have been the sum-total of this effort. The original tree never fruited with Downing, presumably because of the northern latitude of his location, but a budded tree was sent to Henry Lyons, of Columbia, South Carolina, about 1855. The variety was placed in the hands of the late P. J. Berckmans, widely known during his lifetime as a pomologist and nurseryman, of Augusta, Georgia, and he began its dissemination in 1858. The latitude of Augusta was too far north for this variety to succeed, and it was not until it was grown in Florida and southern Texas that its regional adaptability became apparent. The varieties of this race, all of which trace to this original Honey tree, are suited to conditions as far south as are those of the Peen-to race, but they extend somewhat farther north.

Probably less than twenty varieties comprise all of this race that have become prominent enough to be listed in

[1] Fla. Expt. Sta. Bull. 73, "The Honey Peach Group," by F. C. Reimer.

nursery catalogues. Several of these have been of little value and are probably no longer propagated. A large proportion of them are direct seedlings of the Honey variety, and most of them have originated in Florida. Some of the leading sorts other than the Honey are: Climax, Florida Gem, Hastings, Imperial, Oviedo, Pallas, and Triana.

Spanish race.

This race apparently has a much longer record in America than either of the two previously mentioned. Onderdonk termed this group the Spanish race because he was unable to trace its origin farther back than its occurrence in Spain. It appears to have been introduced into Mexico from Spain by Catholic missionaries nearly 300 years ago, and it seems to have come to Florida in the same manner. The varieties of this race are grown mostly in the Gulf states and quite largely in the coast regions of Texas. Representative varieties of this race named by Price[1] include Cabler, Druid, Galveston, Guadalupe, La Reine, Onderdonk, Texas, Victoria, and a few others. A considerable proportion of the varieties of this race has originated in Texas. A few varieties have come from Florida.

In its range the Spanish race overlaps the other races. Its southern limits pass the northern limits of the Peen-to, extending nearly as far as the South China race. It extends both farther south and farther north than the North China, and overlaps considerably the southern extension of the Persian race.

Price indicates that peaches of this race were early distributed by the Spanish among the Indians. It is, therefore, sometimes referred to as the "Indian race."

[1] Tex. Expt. Sta. Bull. 39, "The Peach," by R. H. Price.

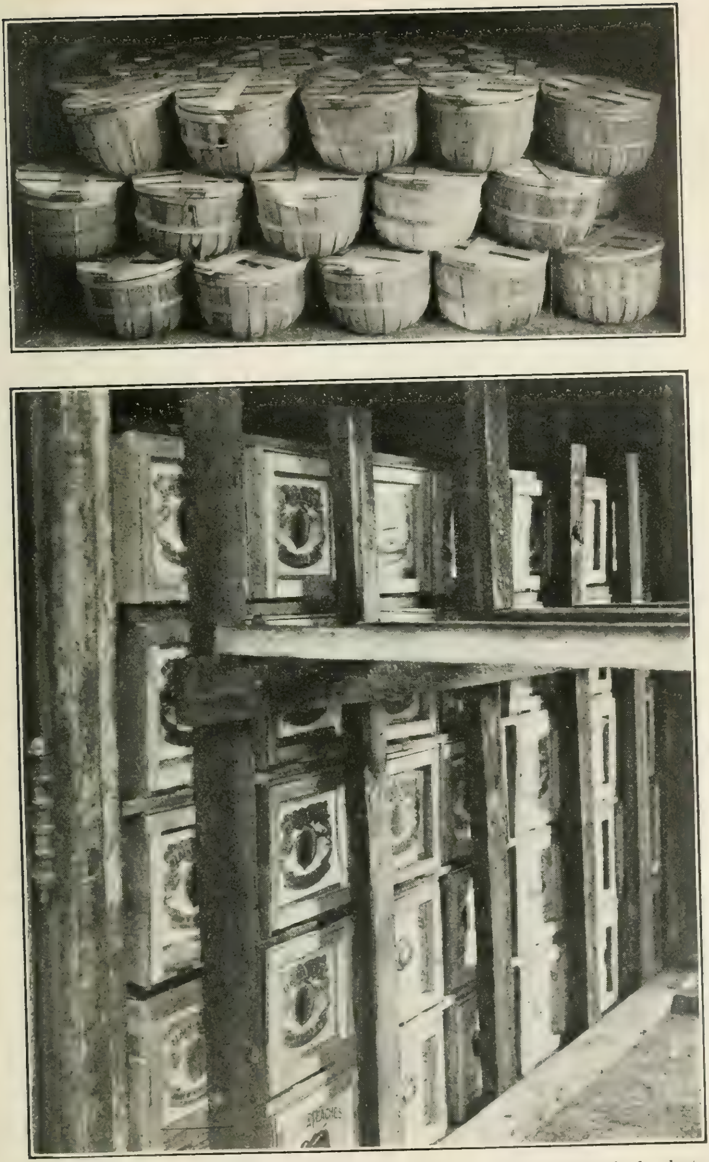

Plate XXXI. — Loading in the Car. *Top*, bushel baskets properly stacked; *bottom*, Georgia carriers braced to prevent movement of packages in transit.

North China race.

This race consists of the Chinese Cling variety, which appears to be the original member of this group introduced into the United States, and its progeny. The name "Chinese Cling Group" has been proposed by Powell [1] as a more appropriate designation for this group, and it has some advantages as does the name "Honey" race as a substitute for the name "South China" race.

Onderdonk states: "This race as far as we have become acquainted with it, consists of the Chinese Cling and its numerous progeny."

Powell has given a rather full account of the development of this race in America, as follows:

"There have been two principal importations from the Orient from which the American varieties have largely descended. The first, as far as we can learn, was in the form of potted peach trees, probably imported by the late Charles Downing, in 1850, through Mr. Winchester, the British consul at Shanghai, China. The variety was received under the names of 'Chinese Cling' and 'Shanghai,' and each name was supposed for a time to represent a distinct variety, but where grown side by side they proved to be identical. The variety was probably first fruited by Mr. Henry Lyon, Laurel Park, S. C., to whom one of the original potted trees was sent by Mr. Downing in 1850.[2] The Chinese Cling [3] under the name Shanghai also fruited in 1850 with R. Choate, near Boston, and was exhibited in September of that year

[1] Del. Expt. Sta. Bull. 54, "The Chinese Cling Group of Peaches."

[2] For a fuller account of the early importation of the variety see the *Horticulturist*, 1855, pp. 286, 472; Downing's "Fruits and Fruit Trees," 1857, under the varieties Chinese Cling and Shanghai; Proc. Am. Pom. Soc. 1858, Discussion of Peaches.

[3] Hovey's *Mag. Hort.*, 1851, p. 475.

before the twenty-third annual meeting of the Massachusetts Horticultural Society. It was exhibited also in 1857 [1] before the same society under the name 'Shanghai' by Nahum Stetson, Bridgewater, Mass. The name 'Bridgewater' was suggested for the variety at that meeting, but the name died with the suggestion. We have been unable to trace the exact history of these early New England introductions.

"The second important introduction was made by Dr. William A. W. Spottswood, of the United States Navy, Fleet Surgeon of the East India or Asiatic Squadron from 1857 to 1860, and, so far as we know, is recorded here for the first time. Dr. Spottswood brought a quantity of peach stones from Japan in 1860, and presented them to the late Judge Campbell, an enthusiastic amateur horticulturist of Pensacola, Fla. Judge Campbell planted the seed, but was soon obliged to leave his home on account of the evacuation of Pensacola. On his return home in 1864 he found much of the place destroyed and the fences burned, but by careful treatment the peach seedlings grew into great vigor by 1867. The trees were then bearing, and some of the peaches measured ten and eleven inches in circumference. These seedling trees were greatly admired by all who saw them, and Judge Campbell gave buds to all who desired them."

Some of the most important varieties at the present time belong to this group. Besides the widely known progenitor of this race, the Chinese Cling, there may be mentioned the Elberta, Carman, Connet, Belle (*Belle of Georgia*), Family Favorite, Greensboro, Hiley, Waddell, and others.

It is probable, however, that a considerable proportion of these varieties are crosses with Persian varieties. In most

[1] Rep. Mass. Hort. Soc., Sept. 5, 1857, in Hovey's *Mag. Hort.*, 1853, p. 470.

cases the varieties have originated as chance seedlings and of but few of the varieties is more than one parent known. However, the varieties are grouped with the Chinese Cling race because the characteristics of that group predominate in them.

Persian race.

Onderdonk's statement in part concerning this race is: "The race includes all varieties springing from the importation from Persia to Italy during the reign of the Emperor Claudius, which was introduced into Great Britain about 1550 and to the American colonies about 1680. They are all late bloomers and cannot carry their foliage through the growing season of the southern portion of the belt in which they are cultivated. This race includes the varieties usually propagated in the northern nurseries and composes the bulk of the northern orchards."

It is of interest to reflect that the statement quoted was published in 1887. The expression with regard to the bulk of the northern orchards being composed of varieties of this race was then in accord with the fact, but since that time the most prominent varieties named above under the discussion of the North China or Chinese Cling group have originated, and to a large extent they now comprise the northern orchards. As pointed out, however, it is probable that many of them contain "Persian blood," though the predominating characters are those of the Chinese Cling group.

Some of the better-known varieties of the Persian race named by Price are: Alexander, Crothers, Early Hale, Foster, Heath, Gold Drop, Hynes, Ingold (*Lady Ingold*), Late Crawford, Mountain Rose, Oldmixon Free, Picquet, Reeves, Rivers, St. John, Salwey, Tuskena (*Tuscan*), Walker.

CHARACTERISTICS OF THE DIFFERENT RACES OF PEACHES

With these general statements presented in regard to the significance of the different races, a more detailed consideration of their characteristics naturally follows. These have been set forth by Price[1] somewhat fully. The following descriptions are adapted from his work. It may be stated here that both Price and Gregory[2] recognize considerable taxonomic value in the leaf glands and serrations, but for the present purpose it is not necessary to discuss these features.

1. *Peen-to race: Seed* — Nearly round (in the Peen-to variety), much compressed at the ends, corrugations small, somewhat rounded. *Winter-buds and terminal branches* — Buds small, oblong, rather sharp-pointed and grow close to the limbs; branches smaller and more willow-like than in any other race. *Tree* — Rather large, vigorous, branches willow-like; flowers large (Plate XV), blooms at a low temperature, leaves narrow and long. Adapted to the northern part of the citrus belt. Seedlings variable, giving rise mostly to trees that produce oblong fruits rather than fruits compressed as in case of the Peen-to variety. Plate XXVII (*upper right*) shows the characteristic flat or compressed form of the Peen-to peach. Plate XXVII (*lower center*) is the Waldo variety, a seedling of the Peen-to. Hume suggests that it contains an admixture of the Honey race. Plate XXVII (*lower left*) shows a Jewel peach which is a seedling of the Waldo. The Jewel and Waldo indicate the oblong form of the Peen-to derivatives.

(2) *South China or Honey race: Seed* — Oval with apex slightly recurred, corrugations slight, prominent flange on

[1] Tex. Expt. Sta. Bull. 39.
[2] Cornell Univ. Expt. Sta. Bull. 365.

one side. *Winter-buds and terminal branches* — Buds very prominent, round to oval, two and three buds often occurring at the same point, dark red in color and stand out from the limb rather prominently; branches not so slender as in the Peen-to. *Trees* — Medium size, branches less willowy than the Peen-to; blossoms large (Plate XV); foliage small and slightly conduplicate, color dark green hanging late in the season; requires short season of rest; fruit rather small, somewhat oval in shape, suture deep at basin; apex long and recurved. Adapted to more southern climates than any other race except the Peen-to. Plate XXVII (*lower right*) shows typical fruits of the Honey variety.

(3) *Spanish race: Seed* — Large oval, nearly flat, apex prominent, corrugations very long and wide, running more longitudinally at the base than in other races, flange on one side often prominent. *Winter-buds and terminal branches* — Buds larger than those of the South China race and usually occur singly on the new growth; short, naked places where there are no buds on the wood, which is not the case with the Peen-to and South China races; color of buds is dark grayish; branches rather slender but more stocky than in the South China race. *Tree* — Very large as a rule; limbs large, long, spreading inclined to droop; blossoms usually large; foliage small and nearly always flat, hangs late and remains green during droughts, turning yellow in the fall before dropping; fruit generally yellow. Adapted to isothermal lines north of which the members of the South China race thrive.

(4) *North China or Chinese Cling race: Seed* — Nearly round, very thick, corrugations rather slight and irregular, apex rather prominent. *Winter-buds and terminal twigs* — Buds slightly larger than in the Spanish race and somewhat

more pointed; branches short, thick, stubby, bark dark grayish in color. *Tree* — Dwarfish, blooms later than the Persian varieties; foliage very large and flat, in the South turning a peculiar dull pea-green in the fall; hangs well during drought but falls earlier in the autumn than some others. Adapted to zones north of those in which the members of the Spanish race thrive. Plate XXVII (*upper left*) shows an Elberta peach which is a seedling of the Chinese Cling variety. It is commonly considered a member of the North China or Chinese Cling race but it has Persian blood also in its parentage.

(5) *Persian race: Seed* — Somewhat round, more flattened at the base than in any other race; corrugations prominent towards the apex, seldom extending to the base, apex more or less prominent. *Winter-buds and terminal branches* — Buds about the size of those of the North China race but a little more oblong, blunt tips are characteristic; long naked spaces when buds are absent; bearing wood usually dark red. *Tree* — Medium size to large; limbs short and thick; bark usually rich purplish red on young wood; blossoms either large or small (Plates XV and XXVII) (*upper, center*); foliage crumpled and conduplicate, with purplish tinge before falling; drops early; trees requiring a long resting period, indicating, as is assumed, a northern origin for the race.

CHAPTER XVII

PICKING AND PACKING THE FRUIT

In the foregoing chapters the discussions have had to do with the planting and maintenance of peach orchards; in other words, with production problems. Attention is now directed to the operations which are concerned with the picking of the fruit and its preparation for market. These operations, together with those connected with the transportation and marketing features, are all-important. They represent the culmination of the peach-grower's efforts for the season. The activities incident to growing the fruit extend over a period of months. On the other hand, the picking and marketing operations, in many sections at least, are over within a period of a few weeks. It is during this relatively short space of time that the peach-grower reaps the reward of his labor.

Moreover, many excellent crops of fruit are grown and brought in perfection to maturity and then are lost, wholly or in part, to the grower because he fails in some of the essential features of marketing. Not every good grower is an equally good salesman of fruit. It is in part for this reason that the average grower is fortunate if he can market his fruit through some sort of coöperative association whose manager is skillfully trained in the requirements of marketing

and who has adequate business ability to meet those requirements effectively. The usual methods of distribution will be touched on briefly on later pages.

In order to handle a crop successfully, the grower must anticipate every need in the way of packages, equipment, other supplies, and labor and make adequate provision for them in advance of the picking season. If this is not done, costly delays in obtaining necessities are inevitable. As soon as the "June drop" is over, he should begin to estimate the probable size of the crop and place orders for all necessary supplies for handling the fruit later on.

PICKING THE FRUIT

The organization for picking the fruit naturally should be governed by the size of the orchard, the amount of fruit to be handled, and the character of the help employed. With experienced labor, comparatively little supervision of individual pickers may be required; otherwise, the pickers should be divided into small gangs, each working under the supervision of a well-trained foreman.

Picking baskets similar to those shown in Plate XXVIII (*top*) are commonly used. These are firmly made splint baskets, holding one-half bushel and with the handle hinged at points of attachment. The baskets are sometimes lined with burlap to protect the fruit from bruising. Another type used in picking, an oblong splint basket, is seen in Plate XXVIII (*center*). A small stick is commonly nailed across the top between the points where the handle is attached to make the basket more rigid. Tin or galvanized iron pails holding two and one-half or three gallons, as well as other receptacles, are also used more or less in picking.

Step-ladders are needed in most orchards to enable the pickers to reach much of the fruit, though where the trees are pruned as suggested in connection with Plate XIII (*top*) the pickers can reach the fruit from the ground.

The details of distributing the picking baskets and assembling them after they are filled will vary to meet individual needs and conditions. Commonly, when the fruit is taken to a central packing-house, the baskets are returned to the orchard by the wagon which takes the fruit to the packing-house, as it returns to the orchard, and are distributed along the rows by the driver or the foreman.

As the baskets in turn are filled, they are placed in the shade of the trees, since exposure to the sun is to be avoided after the fruit is off the trees, the baskets commonly being assembled by the pickers along some designated row or adjacent rows for convenience in collecting when being loaded for transit to the packing-house. A low wheeled orchard truck with body supported on springs, as shown in Plate XXVIII (*top*), is one of the most convenient types of wagons for use in an orchard. A body with a double deck, thus materially increasing the capacity, is desirable under some conditions.

Well-loaded peach trees are commonly picked over three or four times in order to harvest the entire crop at the proper degree of maturity, though when the trees are well pruned and the crop develops uniformly, aided by careful thinning earlier in the season, it may be possible to gather the crop at a single picking. Or, under some conditions, especially if ripening is prolonged by cold weather, as many as six or eight pickings may be necessary. If the weather is warm and the fruit ripens rapidly, picking every day may be necessary in order to avoid over-ripeness, though picking

on alternate days is more common. The variety is a factor in this respect, however, since some ripen more rapidly than others, or because of firmness of texture one variety can be allowed to advance a little farther than another before picking is necessary.

While most of the details of picking can be reduced rather definitely to rules of practice, the most important one — the determining of the degree of maturity at which the fruit should be picked — is largely a matter of experience on the part of the picker. To be at its best in quality, a peach should ripen or attain approximate eating condition on the tree. For immediate consumption, therefore, the fruit may be allowed to mature fully before it is picked. However, for distant shipment this cannot be done, as the fruit would be too soft to carry well. On the other hand, if picked too immature, it will shrivel without ripening properly and be lacking in flavor.

The most favorable degree of maturity for long-distance shipment is that termed "hard ripe." In this condition the fruit has lost the solid, unyielding hardness characteristic of the green state, yet it is firm to the touch, not having begun to soften as in the later stages of ripening. The picker must learn to recognize this "hard ripe" condition by the eye rather than the touch. The "touch method" would inevitably result in bruising much of the fruit and thereby injuring it for market purposes. When a fruit begins to lose what is sometimes called its "chlorophyl green," that is, the green color which is like the green of the leaves in quality though not in intensity, and to assume a yellowish tinge in case of a yellow variety, or a creamy white shade in case of a white variety, then it has reached the degree of maturity for long-distance shipment or for holding a relatively long time.

When the fruit has reached the condition indicated by change of color, the stem will separate quite readily from the tree, whereas the articulation of stem and spur does not break easily nor freely prior to the beginning of maturity.

In all handling of the fruit, great care must be exercised not to bruise it in the slightest degree. It is not alone the injuries which are readily seen that are dangerous, but even such slight breaking of the tissues under the skin as result from pressing a fruit too hard in the hand will predispose it to decay. Every precaution in handling the fruit, therefore, should be taken to avoid injury.

Pickers commonly work by the day, though sometimes by the basket. In either case it is advisable in working a large crew, in the beginning of the harvest, even if not throughout the season, to assign each picker a number and a set of checks bearing the corresponding number and then require each one to place a check in every basket. In this way a picker who fails to do good work can be detected without fail and his faults either corrected or the picker transferred when his unfitness for the work is demonstrated.

PACKING THE FRUIT

Packing-houses.

Under some conditions the fruit can be packed to advantage in the orchard. In case of young trees, especially on newly cleared land where the stumps still remain in considerable numbers, it may be more convenient for the pickers to carry the fruit to a central point in the orchard than to haul it in a wagon to a more distant place, the packing equipment being moved frequently to accommodate the pickers. An orchard packing scene is shown in Plate XXVIII (*center*).

In general, however, the fruit can be handled in a packing-house more satisfactorily than in the orchard. The size and arrangement of a packing-house should be governed by the amount of fruit that is to be handled. A simple shed or even tent will serve the purpose for a small orchard.

A packing-house of large capacity and an interior view of the same house, are shown in Plate XXIX. The building is two stories high, the upper floor being used for the storage of packages and other supplies. The sides are in sections which are hinged at the top and raised as desired. The fruit is unloaded from the orchard wagons along the sides of the packing-house, where it is readily passed to the packers, who work on either side of the central section of the house. As may be seen, the location is along a railroad siding, thus making the transfer of the packed fruit from the house to the car very convenient.

With the essentials of a desirable packing-house in mind, the grower should have no serious difficulty in planning details of arrangement which will meet his needs satisfactorily.

The equipment for a packing-house of large dimensions should include suitable trucks for use in moving the packed fruit to places of exit, also well-arranged packing tables. A fairly well-planned table is shown in Plate XXIX (*bottom*). It consists of a frame over which canvas is stretched, forming a top that yields slightly, thus lessening the danger of bruising the fruit as compared with a hard, rigid top. The shelf along the side of the table supports the packages while they are being filled. This should be in sections, however, rather than continuous for the entire length of the table, so as to permit the packer to reach the center of the table easily. Sometimes a shelf, raised some distance above the

Plate XXXII. — Peach Packages. *Top*, flats properly stacked in the car; *bottom*, Climax baskets.

table and extending lengthwise, is provided on which baskets and other supplies are placed for the convenience of the packers.

In a large packing-house the work must be organized and systematized if it is to go forward smoothly and effectively. An equitable grouping of the labor into packers, handlers, nailers, and the like, is usually necessary. As a rule, all the workers should be responsible to a packing-house foreman or manager, though the owner often serves in this capacity. The handlers should keep the packers supplied with fruit and packages and should remove the latter from the packing tables when filled. The nailers attach the covers to the packages. The handlers may also serve as nailers when the extent of the operations renders it practicable.

While men should be employed for the heavier work about the packing-house, many growers prefer women and girls as packers. They adapt themselves better than men, as a rule, to the details of making a high-grade pack.

Packages.

Several different styles of packages are used in marketing peaches. Some are regional and meet special conditions or needs, while others are widely used or have some significance with respect to the grade of fruit which they are supposed to contain. The Georgia carrier, or crate, Delaware basket, bushel basket, box, flat, and Climax basket are the packages most often used.

The Georgia carrier (Plate XXX) contains six baskets or "tills" each holding about four quarts. This package is widely used among peach-growers for the better grades of fruit. Sometimes a grower is unwise enough to use it for a poor grade, but this practice suggests a purpose to deceive

the purchaser, who would ordinarily expect to find only high-grade fruit in this type of package.

The Delaware basket (Plate XXVII, *center and bottom*) is a splint-made container having a capacity of one-half bushel. It is widely used, especially in some of the eastern peach districts. Fruit of all marketable grades is shipped in it. The ease and rapidity with which fruit can be packed is one of its chief advantages. Besides, it requires less skill to fill it properly than is the case with several of the other types; it is convenient to handle, and its capacity fits the needs of large numbers of consumers.

The bushel basket (Plate XXXI) is being used more and more. It has some of the desirable features of the Delaware basket and is relatively a cheaper package.

The box (Plate XXX) is used but little, if any, by eastern growers, but is common in some of the peach districts of the intermountain and Pacific coast states. Fruit thus packed reaches the mark of the East in some quantity. The box is 18 inches long, $11\frac{1}{2}$ inches wide, and may be 4, $4\frac{1}{2}$, or 5 inches deep, depending on the size of the fruit to be packed.

The flat (Plate XXXI) is more often used for tomatoes, apricots, and plums than for peaches, but the latter fruit is sometimes packed in it. The type of flat most often seen holds four baskets or tills similar to those used in the Georgia carrier. They are placed in the flat in pairs end to end.

The Climax basket (Plate XXXII) most often used for peaches is the size designated as the "20-pound" or third-bushel basket. However, not many growers use this package for peaches.

Various other kinds and sizes of packages are used occasionally in marketing peaches, but it is unnecessary to discuss them here.

Sizing and grading.

Probably the average grower does not give enough attention to sizing and grading the fruit preparatory to packing. For clearness of understanding, it should be stated that sizing refers to the separation of the fruit according to the size of the individual specimens, while grading has to do with its separation according to degree of perfection in finish, color, and freedom from blemishes. Grading must obviously be done by hand, and sizing is most commonly accomplished in the same manner, though mechanical sizers are sometimes used. A question may consistently be raised, however, as to the extent to which the fruit is bruised when it is run through a sizing machine, except possibly when it is picked in a very hard condition.

The need of accurate sizing is evident in packing the baskets used in carriers and flats and in filling boxes and Climax baskets. So far as packing is concerned, less careful sizing is necessary in filling the bushel and the Delaware basket, though from the standpoint of marketing, careful attention to sizing doubtless pays whatever the type of package used.

Skill in sizing when done by hand, as also in packing, comes only with experience. Sizing, except when done mechanically, and grading are usually done by the packer as he selects the fruits for the package. In packing the Georgia carriers, the three baskets that go in the bottom tier are put in the crate and then filled, following which the top tier is similarly handled. If the baskets were filled before they are put in the crate, it would be practically impossible to get them in place.

In filling the baskets for the carrier and flat, also in packing the box and Climax basket, the fruits must be put in place

one by one. This is not necessary, however, in packing the bushel and the Delaware basket, though it is a common practice to face the tops somewhat systematically and carefully.

But little attention has been given to reducing sizes to specific dimensions or to standardizing grades. However, Blake and Connors[1] propose the following sizes, especially with a view to packing in the Georgia carrier:

Small — All peaches less than 7 inches in equatorial circumference.

Medium — All peaches between 7 and 8 inches in equatorial circumference.

Large — All peaches that exceed 8 inches in equatorial circumference.

A second grouping modifies the medium and large sizes thus:

Medium — All peaches from 7 to $7\frac{3}{4}$ inches in equatorial circumference or packs in carriers of 11-10-11, 10-10-10, or 9-9-9. That is, in each of the individual baskets of a Georgia carrier there are three tiers of fruit, the bottom one with 11, the middle with 10, and the top one with 11 fruits, or with the smaller numbers as suggested, depending on the size of the fruits. These styles of pack are suggested in the three crates shown in Plate XXX, though the sizes do not conform in all cases to the above specifications.

Large — All peaches $7\frac{3}{4}$ inches in equatorial circumference and above.

Grades of fruit on the basis of appearance, freedom from blemishes, color, and other points of perfection are not as well standardized among growers as are the grades of apples. The terms "fancy" and "extra fancy" are the most com-

[1] N. J. Expt. Sta. Circ. 58.

monly used grade designations. If consistently applied, they should mean respectively fruit that is fairly well colored, practically free from blemishes and in general not below medium size, and fruit usually above medium size and possessing all the other points of merit in a high degree.

Details of packing.

It has been pointed out that the details of packing, so far as they concern the placing of the fruit in the packages, are acquired only by practice. However, the packer needs to regard certain essentials from the very beginning.

At every step, the fruit should be handled with great care, and no specimens which are bruised or the skin of which is punctured or broken however slightly should be packed. Decay is very likely to develop in such specimens while in transit to market if they are included.

Of equal importance is the close placing of the specimens in the package or individual containers. While the fruits should not be jammed into place, there should be no slack space and the packages should be filled full enough so that when the covers are nailed on every fruit will be under sufficient pressure to hold it in place. Any shaking about of fruits will inevitably result in bruising, not only the loose fruit, but those with which it comes in contact. Even if decay does not result, the bruised condition of the fruit will detract from its appearance and will reduce its market value. It is for this reason, in part, that accuracy in sizing is essential for the proper packing of fruit in the packages in which each specimen is placed individually in position.

The different ways of arranging the fruits in a package are sometimes referred to as the "straight" or "square" pack, "offset," and "alternate," depending on the position of the

fruits with relation to one another. The square and offset packs are shown in Plate XXX (*bottom*). The "alternate" differs but slightly from the offset. If the fruits in the middle box in the same figure were of such size that a given number in the first and each alternate row thereafter exactly filled the space crosswise the box, then in the second and corresponding alternate rows with each specimen placed in the angle formed between each two adjacent specimens, there would be one fruit less than in the other rows. Such an arrangement of the fruits is designated an "alternate" pack. The difference between this style pack and the "offset" is relatively slight. The same terms are frequently applied to corresponding arrangements of the fruit in the carrier baskets.

If a grower desires to make an especially fancy pack, he sometimes wraps the fruit in paper. This is a common practice when the box is used (Plate XXX). The bulk of the commercial crop, however, is packed without wrapping. All packages should be firmly made, and when filled, the covers securely nailed or otherwise fastened in place. If not, the packages will be racked and broken in transit and in handling and the fruit damaged.

CHAPTER XVIII

TRANSPORTATION, STORAGE, MARKETING

TRANSPORTATION

It is to be assumed that the peach-grower selected his location with respect to good transportation facilities. Such facilities may be represented by railroads, boat lines, or perhaps both, and in case of local distribution, good roads. With respect to local markets, the use of auto-trucks has greatly facilitated delivery in many instances and increased materially the distances which it is practicable to cover. In most cases in which peaches are delivered by boat, a comparatively short time in transit is required, and the problems of transportation are relatively simple.

The great bulk of the commercial peach crop is moved by rail, much of the fruit being shipped distances varying from perhaps several hundred to three thousand miles, or from the Pacific coast to the Atlantic seaboard.

While small lots and less than car-lots are commonly shipped by express, fast freight service in refrigerator cars is essential in distributing the bulk of the crop. This implies also adequate car-icing facilities. The object of refrigeration in transit is to provide a temperature for the fruit sufficiently low to retard the ripening processes. A temperature of 40° to 45° or even lower, if possible, is desirable.

Precooling.

One of the difficulties experienced in shipping perishable products such as peaches is due to the slow cooling of the fruit to a temperature sufficiently low to retard ripening when placed in a refrigerator car. As a result of too tardy cooling, it often arrives in an over-ripe condition, or so far advanced in maturity that it does not hold up well when placed on sale.

In practice, a large quantity of warm fruit is commonly placed in the car at one time. The heat in the fruit for a time counteracts the refrigerating effects of the ice in the bunkers, and it is often several days before the temperature in the car again drops low enough to retard effectively the ripening of the fruit.

To overcome this difficulty the fruit is sometimes pre-cooled or placed in refrigeration — sometimes in a compartment built for the purpose where the temperature can be run considerably below the freezing point if desired — and cooled to a temperature of perhaps 40° F. before it is loaded in the car. When thus handled, the full effect of the refrigerator car operates to maintain the fruit at such a temperature that the ripening processes are approximately stationary, or at least much retarded.

Another means of greatly facilitating the cooling of the fruit and increasing the effectiveness of the refrigeration in the car is by using a certain quantity of salt with the ice in the bunkers. This simple measure, as proved by the Federal Department of Agriculture, results in so promoting the refrigeration that the fruit is very much more quickly cooled than when it is not used.

Loading the cars.

Whatever the style of package used, it is of the utmost importance that the individual containers be so placed in the car that their positions do not change en route to destination. It is as disastrous practically for a package to be loose in its position as it is for individual fruits to be loose within the package. In either case the fruit will be bruised and ruined for market purposes.

The type of package used will obviously influence the manner in which a car is loaded, as will also, in respect to certain details, the size of the car.

In loading bushel baskets or Delaware baskets it is commonly advised to load from "end to end," that is, the first packages are placed in a continuous row along the side of the car opposite the entrance door and extending from one end of the car to the other. A second row is similarly placed adjacent to the first one following which a second tier may be put in position corresponding to the first row.

The position of the individual packages in the second tier in relation to those in the first tier will depend on the way they fit into the car. The placing of baskets in a car is entirely comparable with the placing of individual fruits in a Georgia carrier basket or in a box. The pack may be the "straight" or "square," the "alternate," or the "offset."

If the first is used, the packages are placed so that each one is squarely against, or stands directly opposite, those adjacent to it. In the alternate plan the packages overlap, each one standing in the angle made by two adjoining packages in the adjacent row, and each row has one less package, or one more, as the case may be, than those on either side. In the offset packing, the position of the packages with relation to each other is substantially the same as in the alternate arrange-

ment, but there is the same number of packages in each row across the car. This method is naturally used where the car is about half the width of a package wider than the space occupied by a given number of packages, while the alternate arrangement prevails where a given number of packages completely fill the width of the car. "Offset" loading is shown in Plate XXXI (*top*).

In straight packing the packages in the second and subsequent tiers are placed directly on top of those in the lower ones, but in the other methods the packages in each tier alternate with those in the one below. Thus in all tiers except the lower, each package aside from those next the car wall stands on the adjacent sides of either two or four packages, depending on the relation of the size of the car to the space occupied by a given number of packages. The alternate and offset methods of arrangement make firmer and more stable positions for the packages than does the straight packing. This relation of different tiers to one another is illustrated in Plate XXXI.

In loading Delaware baskets, every alternate one is placed bottom-side up so that the flare of the sides will thus be equalized in spacing. This arrangement is suggested in the manner of loading the wagon shown in Plate XXXVIII. A car of ordinary size holds about 430 of the bushel baskets when piled four tiers high and about the same number or a few more Georgia carriers.

Georgia carriers, boxes, and flats are usually loaded straight, the packages in one tier being placed directly above those below. This arrangement is suggested in Plates XXXI (*bottom*) and XXXII (*top*). It will be noted that a narrow space is left between the rows of packages. This is needed in order to aid in the thorough circulation through the car

of the cold air. If this does not occur, the temperature in different parts of the car will vary greatly.

Narrow strips of board about $\frac{3}{4}$ inch thick and as long as the car is wide are nailed across each end of each carrier as may be seen in Plate XXXI (*bottom*), and across each alternate tier in the use of boxes or flats (Plate XXXII, *top*). This is done in order to hold the packages securely in position.

When a car is loaded from each end towards the center and a space between the doors remains unoccupied, it is important that the packages be very securely braced to hold them in position. Most of the movement in shunting the cars is endwise. Hence if the bracing is not strong, a good deal of racking of the packages is inevitable. The manner of bracing carriers is shown in Plate XXXI. The lumber commonly used is 2 × 4-inch joist. Supports corresponding to those seen in the figure are placed against the crates on the other side of the doorway. One brace extends to the ceiling of the car to prevent the supports from working upward and thus becoming released at the bottom. Some similar method or one that will make the packages equally secure should be used for all other types of packages.

When a car is loaded and the shipping details attended to, the responsibility of movement passes to the transportation company.

COLD STORAGE

Storage is of only minor importance, relatively, with peaches, yet within certain rather narrow limits it may play an important part in the net returns secured for the fruit. The durability of peaches in storage is short. They soon become mealy, lose flavor, and if held too long, the flesh turns

brown even though the exterior may appear normal and attractive.

Fruit that is to be stored should be picked when well colored but still firm and for best results it should be put in storage as quickly as possible after it is picked. A temperature of 32° gives the best results as measured by the length of the storage period of the fruit. Even under the best conditions the fruit should not be held longer than about two weeks, since the deterioration mentioned above follows with most varieties soon after this period, the browning occurring within three or four weeks. A storage period of even two weeks, however, may make the difference between a heavy loss and a good profit to the shipper if the fruit happens to reach the market when there is an over-supply.

MARKETING

It has been pointed out that peach-growing is essentially a manufacturing enterprise and that, as a manufacturer, the grower must adhere closely to fundamental business principles in order to succeed. Therefore, he must handle a well-standardized article. Every package of fruit that is marketed under a particular brand must be just as nearly like every other package handled under the same brand as it is possible to make it. Again, a successful manufacturer must know the markets in which he deals. He must know where he can sell his goods, what his competition is, and from whence it comes, and he must understand when a market has taken as much of a commodity as it will absorb to mutual advantage. Finally, a manufacturer must make effective use of all available knowledge of market preferences and peculiarities with a view to regulating his selling activities accordingly.

While these observations are axiomatic, not every grower is guided by them. Too often fruit that is poorly graded is shipped under a brand which implies a highly standardized product. In this case the brand used serves no other good purpose than to warn the purchaser after one experience to beware. Not infrequently the grower ships with little or no knowledge of market requirements or conditions.

From the nature of many of the marketing problems, it is obvious that the individual grower is at a serious disadvantage. He is necessarily absorbed in getting his fruit ready to ship. He is handling a highly perishable product and must act quickly. Unless he can sell on the track to a local buyer, he usually has no other alternative than to consign to a commissioner merchant in a more or less distant market. In either case, if he is not well informed in regard to prices, market conditions, and the competition he has to meet, his returns are likely to be disappointing.

Many of the marketing problems can be met more successfully by a coöperative shippers' organization than by individual shippers operating independently. It is for this reason, in part, that a grower usually does well in selecting a location for planting his orchard where there are community interests in peach-growing of considerable size rather than to locate where there is no alternative to individual action.

Distribution of the fruit.

One of the most important features of the whole marketing problem is the distribution of the fruit. Not infrequently one market within the shipping radius of a production center is without adequate fruit to supply the demand, while a glut exists in some other market to which a disproportionately large quantity of fruit has been shipped.

When the growers of a community ship through a coöperative organization, its manager should keep fully informed by daily telegraphic reports of the supply of fruit in the markets within his shipping radius in order that he may know where to ship to the best advantage. Thus all the members of the association receive the benefit of market reports at no greater cost for telegrams than would be involved for each one operating separately. Other advantages which require no enumeration here also attend coöperative selling. Fundamental to the success of organized selling, however, is a carefully standardized pack for the different grades and brands of fruit.

In the chapter on varieties, reference was made to the importance of selecting varieties for planting with regard to the sequence in which they ripen. The prominence given to certain regions because of the sequence in which certain important varieties ripen in them with respect to other districts was also pointed out. These facts are again indicated in the present connection. They are highly important in considering competition in the markets and consequently in the distribution of the fruit.

Poor distribution is often equivalent to over-production so far as prices are concerned; conversely, low returns are more frequently due to an unequal and faulty distribution of the supply than because more peaches are produced than the trade can absorb, provided the fruit is placed where every one who wants it can readily obtain it.

The diagram in Fig. 19 shows the comparative shipping season of the principal peach-producing states. In addition, the season for Ontario covers a period of nearly three months, beginning about July 20 and continuing as late or later than any district in the United States.

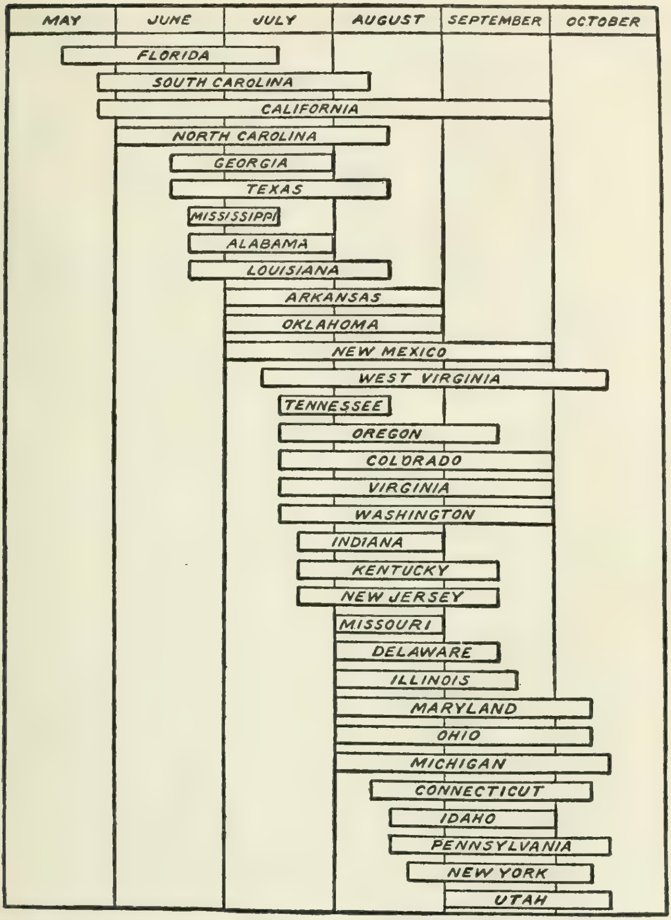

FIG. 19. — Diagram showing the "peach season" in the different states.

In this connection the shipper as well as the grower should consult the ripening dates given for different varieties on pages 354 to 373. With the exception of the fruit grown in Florida, California, West Virginia, and to a limited extent in one or two other states, the great bulk of the fruit shipped consists of the Elberta variety, though the diagram covers both the earlier and later sorts which are marketed in relatively small quantities from some of the peach-producing sections in most states. Therefore, the ripening dates given for the Elberta peach indicate fairly accurately the period of maximum shipment from many different sections throughout the country, and are indicative of the trend of greatest market supply. This, however, varies somewhat from season to season, as does the crop in the different competing districts.

In general, a shipper should aim to supply the markets nearest to his place of production, thus reducing time in transit, and transportation charges, as well as the demands on the railroads. A striking disregard of this practice, resulting in little or no advantage to any one except perhaps the railroad in the freight receipts, was observed a few years ago when a car of Elberta peaches which had been shipped some distance was being unloaded on a local siding, while in the same freight yard on another siding a car was being loaded with local-grown fruit of the same variety to be shipped to a distant state. Reasonable economy in both transportation and handling would seem to have dictated that the fruit grown in the locality should have been used to supply local demands.

While the bulk of the commercial crop is sold either "on the track" at the shipping station or is shipped on consignment to a commission merchant who handles it as the shipper's agent, the fruit received in eastern markets from California is usually sold at auction.

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